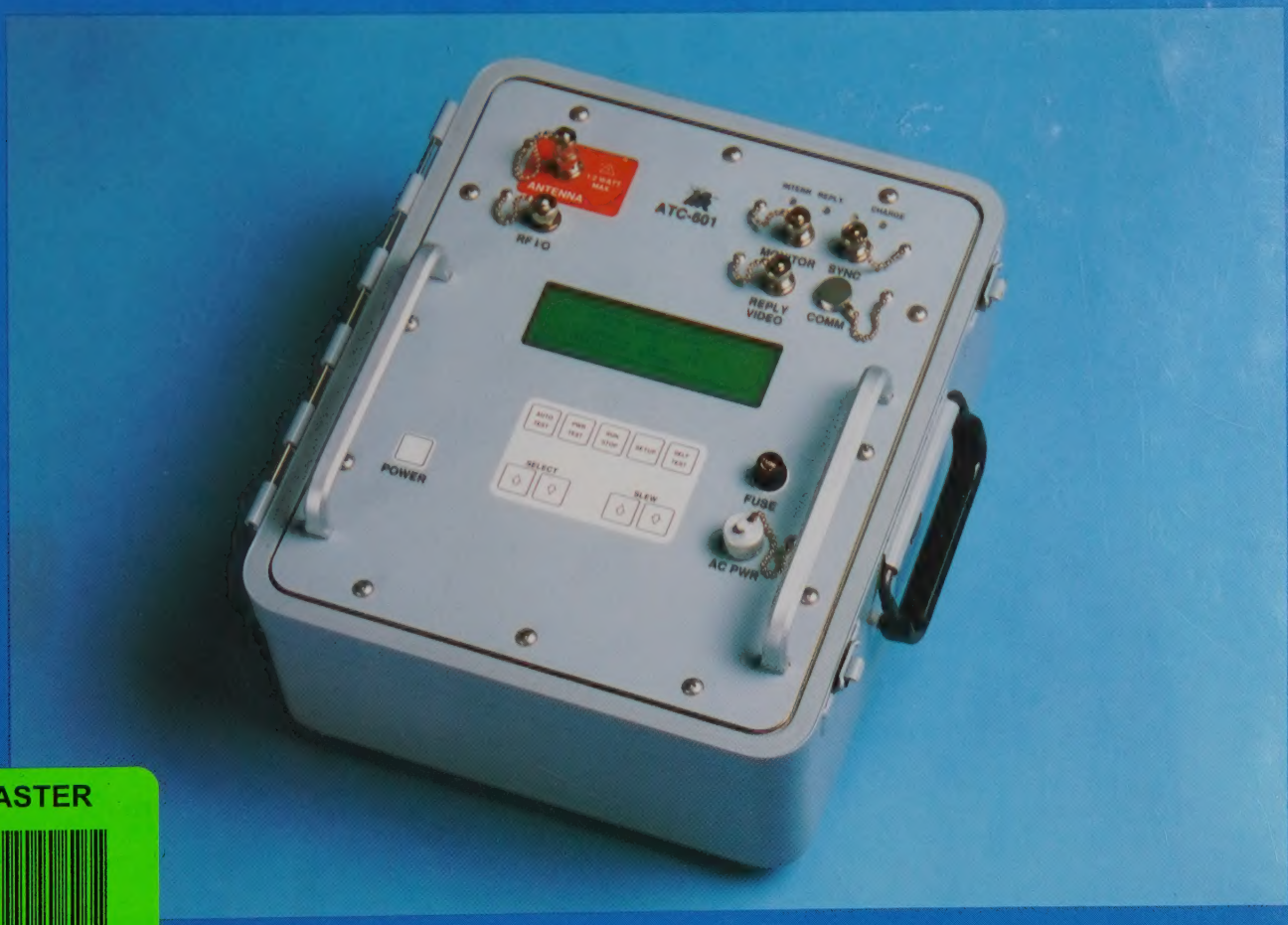
OPERATION MANUAL

ATC-601

RAMP TEST SET



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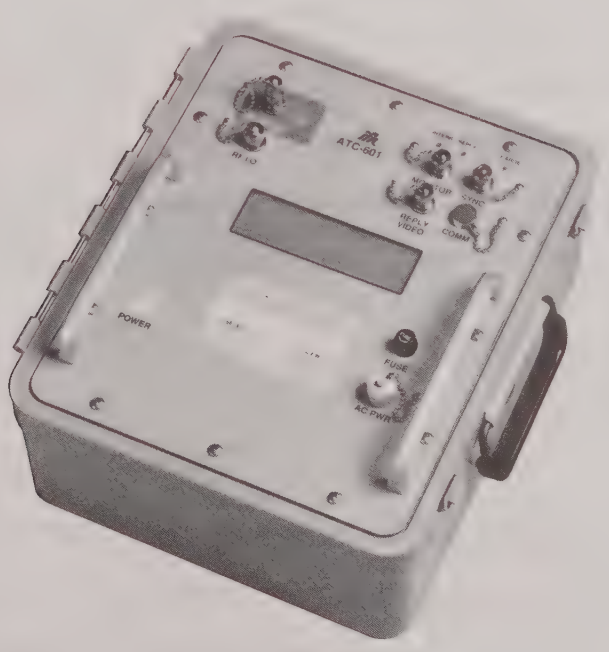
OPERATION MANUAL

ATC - 601
RAMP TEST SET



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OPERATION MANUAL
ATC-601

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Wichita, Kansas

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WARNING

HIGH VOLTAGE EQUIPMENT

THIS EQUIPMENT CONTAINS CERTAIN CIRCUITS AND/OR COMPONENTS OF EXTREMELY HIGH VOLTAGE POTENTIALS, CAPABLE OF CAUSING SERIOUS BODILY INJURY OR DEATH. WHEN PERFORMING ANY OF THE PROCEDURES CONTAINED IN THIS MANUAL, HEED ALL APPLICABLE SAFETY PRECAUTIONS.

RESCUE OF SHOCK VICTIMS

1. DO NOT ATTEMPT TO PULL OR GRAB THE VICTIM.
2. IF POSSIBLE, TURN OFF THE ELECTRICAL POWER.
3. IF YOU CANNOT TURN OFF ELECTRICAL POWER, PUSH, PULL OR LIFT THE VICTIM TO SAFETY USING A WOODEN POLE, ROPE OR SOME OTHER DRY INSULATING MATERIAL.

FIRST AID

1. AS SOON AS VICTIM IS FREE OF CONTACT WITH SOURCE OF ELECTRICAL SHOCK, MOVE VICTIM A SHORT DISTANCE AWAY FROM SHOCK HAZARD.
2. CALL FOR DOCTOR AND/OR AMBULANCE, IMMEDIATELY.
3. IF BREATHING HAS STOPPED; ADMINISTER CARDIO-PULMONARY RESUSCITATION (CPR), AS NEEDED.
4. IF VICTIM IS BREATHING, ATTEMPT TO CONTROL ALL SERIOUS BLEEDING.
5. KEEP VICTIM WARM, QUIET AND FLAT ON HIS/HER BACK.

CAUTION: INTEGRATED CIRCUITS AND SOLID STATE DEVICES SUCH AS MOS FETS, ESPECIALLY CMOS TYPES, ARE SUSCEPTIBLE TO DAMAGE BY ELECTROSTATIC DISCHARGES RECEIVED FROM IMPROPER HANDLING, THE USE OF UNGROUNDED TOOLS, AND IMPROPER STORAGE AND PACKAGING. ANY MAINTENANCE TO THIS UNIT MUST BE PERFORMED WITH THE FOLLOWING PRECAUTIONS:

1. BEFORE USE IN A CIRCUIT, KEEP ALL LEADS SHORTED TOGETHER EITHER BY THE USE OF VENDOR-SUPPLIED SHORTING SPRINGS OR BY INSERTING LEADS INTO A CONDUCTIVE MATERIAL.

2. WHEN REMOVING DEVICES FROM THEIR CONTAINERS,GROUND THE HAND BEING USED WITH A CONDUCTIVE WRISTBAND.

3. TIPS OF SOLDERING IRONS AND/OR ANY TOOLS USED MUST BE GROUNDED.

4. DEVICES MUST NEVER BE INSERTED INTO OR REMOVED FROM CIRCUITS WITH POWER ON.

5. PC BOARDS, WHEN TAKEN OUT OF THE SET, MUST BE LAID ON A GROUNDED CONDUCTIVE MAT OR STORED IN A CONDUCTIVE STORAGE BAG.

   NOTE: Remove any built-in power source, such as a battery, before laying PC Boards on a conductive mat or storing in a conductive bag.

6. PC BOARDS, IF BEING SHIPPED TO THE FACTORY FOR REPAIR, MUST BE PACKAGED IN A CONDUCTIVE BAG AND PLACED IN A WELL-CUSHIONED SHIPPING BAG.

CAUTION: THE USE OF SIGNAL GENERATORS FOR MAINTENANCE AND OTHER ACTIVITIES CAN BE A SOURCE OF ELECTROMAGNETIC INTERFERENCE TO AVIATION RECEIVERS, WHICH CAN CAUSE DISRUPTION AND INTERFERENCE TO AERONAUTICAL SERVICE OUT TO A DISTANCE OF SEVERAL MILES.

CAUTION: USERS OF THIS EQUIPMENT SHOULD SCRUTINIZE ANY OPERATION WHICH RESULTS IN RADIATION OF A SIGNAL (DIRECTLY OR INDIRECTLY) AND ENSURE COMPLIANCE WITH INSTRUCTIONS IN FAA CIRCULAR AC 170-6C, DATED FEBRUARY 19, 1981.

RECORD OF REVISIONS

REV NO.	ISSUE DATE	DATE INSERTED	BY	REV NO.	ISSUE DATE	DATE INSERTED	BY
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INTRODUCTION - ATC-601 RAMP TEST SET

This manual contains ATC-601 operating instructions for ramp testing ATCRBS and Mode S Transponders. It is strongly recommended that personnel be thoroughly familiar with the contents of this manual before attempting to operate or service this equipment.

NOMENCLATURE

In this manual, the ATC-601 Ramp Test Set is also referred to as Test Set, ATC-601 or ATC-601 Test Set.

ORGANIZATION

This manual is divided into five sections as follows:

CHAPTER 1 - OPERATION

Section 1 - DESCRIPTION (physical and mechanical description of ATC-601)

Section 2 - OPERATION (installation; description of controls, connectors, and indicators; performance evaluation; and general operating procedures)

Section 3 - SPECIFICATIONS

Section 4 - SHIPPING

Section 5 - STORAGE

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CHAPTER ONE

ATC-601 RAMP TEST SET

OPERATION MANUAL

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SECTION 1 - DESCRIPTION

1. General Description and Capabilities

A. General

The ATC-601 Ramp Test Set is a ruggedized ramp tester designed for ease of use, portability, reliability and long service life. Power is derived from an internal battery. An ac input connection is provided for battery charging, bench operation or servicing use. Most accessories (Flat Antenna, Antenna Cable, AC Power Cable, Monopole Antenna, Antenna Shield, Fuse and Operator's Guide) are stored in the case lid. The Tripod is stored separately. Refer to Appendix D for description of accessories.

The ATC-601 Ramp Test Set provides PASSED/FAILED verification of ATCRBS and/or Mode S Transponder operation in a ramp environment. The ATC-601 is a ground or air interrogating simulator that transmits Modes A, C and S interrogations. The Test Set accurately analyzes reply pulses, providing reply pulse information and indicating any failures to comply to accepted guidelines.

B. Functional Capabilities

- The ATC-601 incorporates the following features and capabilities:
- Accurate measurements of transponder transmitting frequency, output power and sensitivity.
- Ruggedized construction designed for the conditions encountered in the ramp environment.
- Automatic Test Sequence mode for fast and easy testing.
- Battery backup memory, storing latest test results, indefinitely, until replaced with new test results.
- Built-In-Test (BIT) for confidence testing and fault isolation.
- Soft-press key controls for easy operation.
- Reply pulse verification of delay, width, spacing, format and content.
- Ability to test a transponder in the aircraft from a distance of up to 300 feet (91.4 meters).
- LCD Display with automatic light sensing illumination control.
- RF I/O, Monitor, Reply Video and Sync Pulse outputs for use in bench testing.
- Internal Battery allowing up to two hours of operation before recharge.
- Automatic power shutdown after approximately 15 minutes of non-use when ac power is not connected.
- Size and usability to allow "one person" operation on the ramp.

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- Internal Battery allowing up to two hours of operation before recharge.
- Automatic power shutdown after approximately 15 minutes of non-use when ac power is not connected.
- Size and usability to allow "one person" operation on the ramp.

SECTION 2 - OPERATION

1. Installation

A. General

The ATC-601 is powered by an internal battery. The Test Set contains a battery charging circuit which enables the operator to recharge the battery when connected to ac power.

NOTE: The ATC-601 can operate continuously on ac power for servicing and/or bench tests.

B. Battery Operation

The internal battery is equipped to power the ATC-601 for two hours of continuous use, after which time, the ATC-601 battery needs recharging. When executing the Self Test function, the DISPLAY (14) (refer to 1-2-2, Figure 2) indicates whether the battery is usable or in need of recharging.

NOTE: When battery is low during operation, two small block characters appear on the left side, below the bottom line of the DISPLAY (14) (refer to 1-2-2, Figure 2).

The ATC-601 contains an automatic time-out to conserve power. If a key is not pressed within a 15-minute time period, the Test Set shuts Off (only when using battery power).

C. Battery Charging

The battery charger operates whenever ac power is applied to the Test Set and the POWER Key (11) (refer to 1-2-2, Figure 2) is pressed Off. When charging, the battery reaches an 80% charge in approximately two hours. The battery should be charged every three months (minimum) or disconnected for long term nonactive storage periods of more than six months.

D. Safety Precautions

Listed are several important safety precautions which must be observed during installation and operation. IFR SYSTEMS, INC., assumes no liability for failure of customer to comply with any of the safety precautions outlined in this manual.

(1) Complying with Instructions

Operators should not attempt to operate the ATC-601 without reading and complying with instructions contained in this manual. All procedures contained herein must be performed in exact sequence and manner described.

(2) Power Cord

The power cord is equipped with standard three-prong plug which must be connected to a properly grounded three-prong wall receptacle. It is the customer's responsibility to:

- Have qualified electrician check wall receptacle(s) for proper grounding.
- Replace any standard two-prong wall receptacle(s) with properly grounded three-prong receptacle(s).

WARNING: DUE TO POTENTIAL SAFETY HAZARDS, USE OF THREE-PRONG TO TWO-PRONG ADAPTOR PLUG(S) IS NOT RECOMMENDED.

E. Battery Removal (Refer to 1-2-1, Figure 1.)

STEP	PROCEDURE

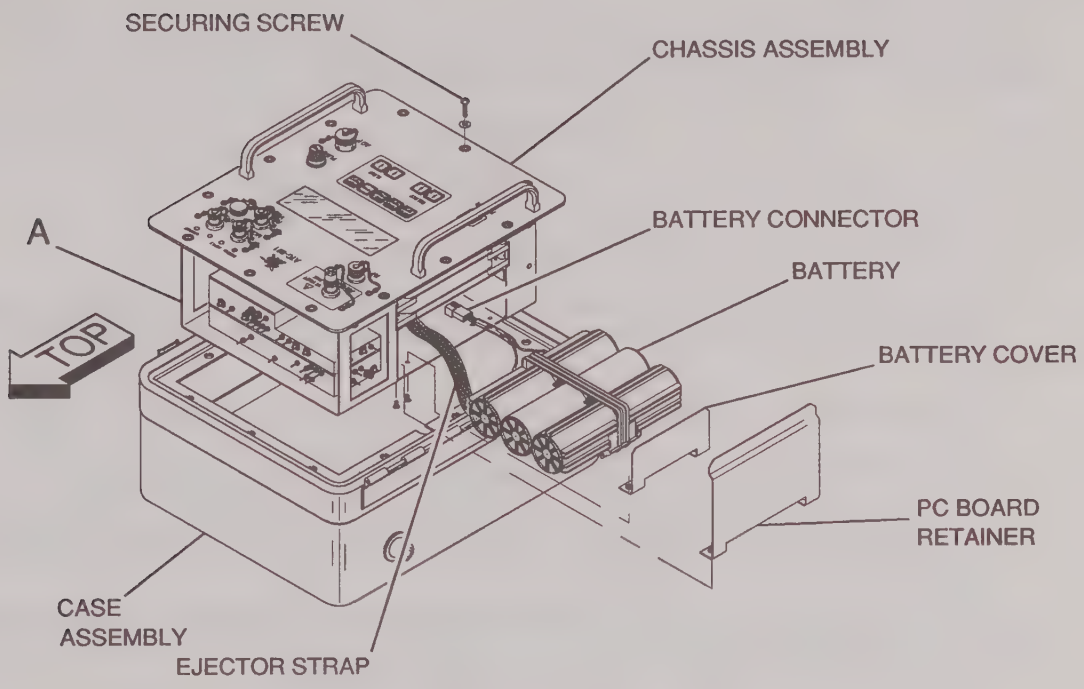
1. Verify ATC-601 is Off and not connected to ac power.
2. Remove 12 securing screws and lift Chassis Assembly from Case Assembly.
3. Disconnect battery connector through bottom of Chassis Assembly.
4. Remove two screws from the bottom of Chassis Assembly and remove PC board retainer.
5. Remove two screws from the bottom of Chassis Assembly and remove battery cover.
6. Pull ejector strap and remove battery from Chassis Assembly.

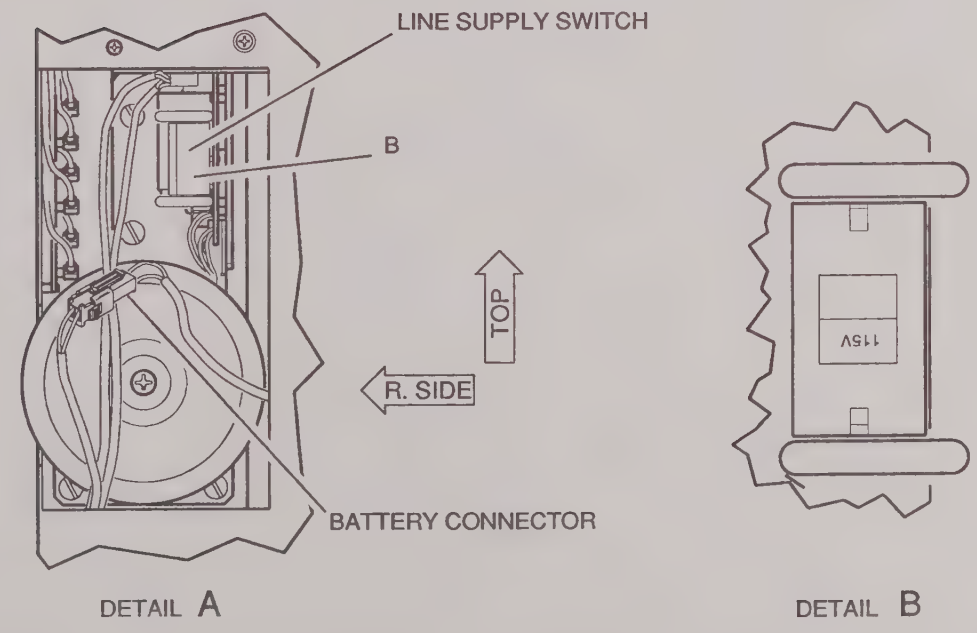
F. Battery Recharging

Unless specified otherwise, refer to 1-2-2, Figure 2 for Controls, Connectors and Indicators used in recharging the battery.

STEP	PROCEDURE

1. Remove cover from AC PWR Connector (7).
2. Refer to 1-2-1, Figure 1. If power source is 103.5-129 VAC, set Line Supply Switch to 115. If power source is 207-253 VAC, set Line Supply Switch to 230.
3. Connect ac power source to AC PWR Connector (7) using AC Power Cable.
4. Verify DISPLAY (14) is Off. If DISPLAY (14) is On, press POWER Key (11).
5. Verify CHARGE Indicator (1) illuminates red.
6. Allow two hours for battery charge or until CHARGE Indicator (1) illuminates green.





Battery Removal and Line Switch Location
Figure 1

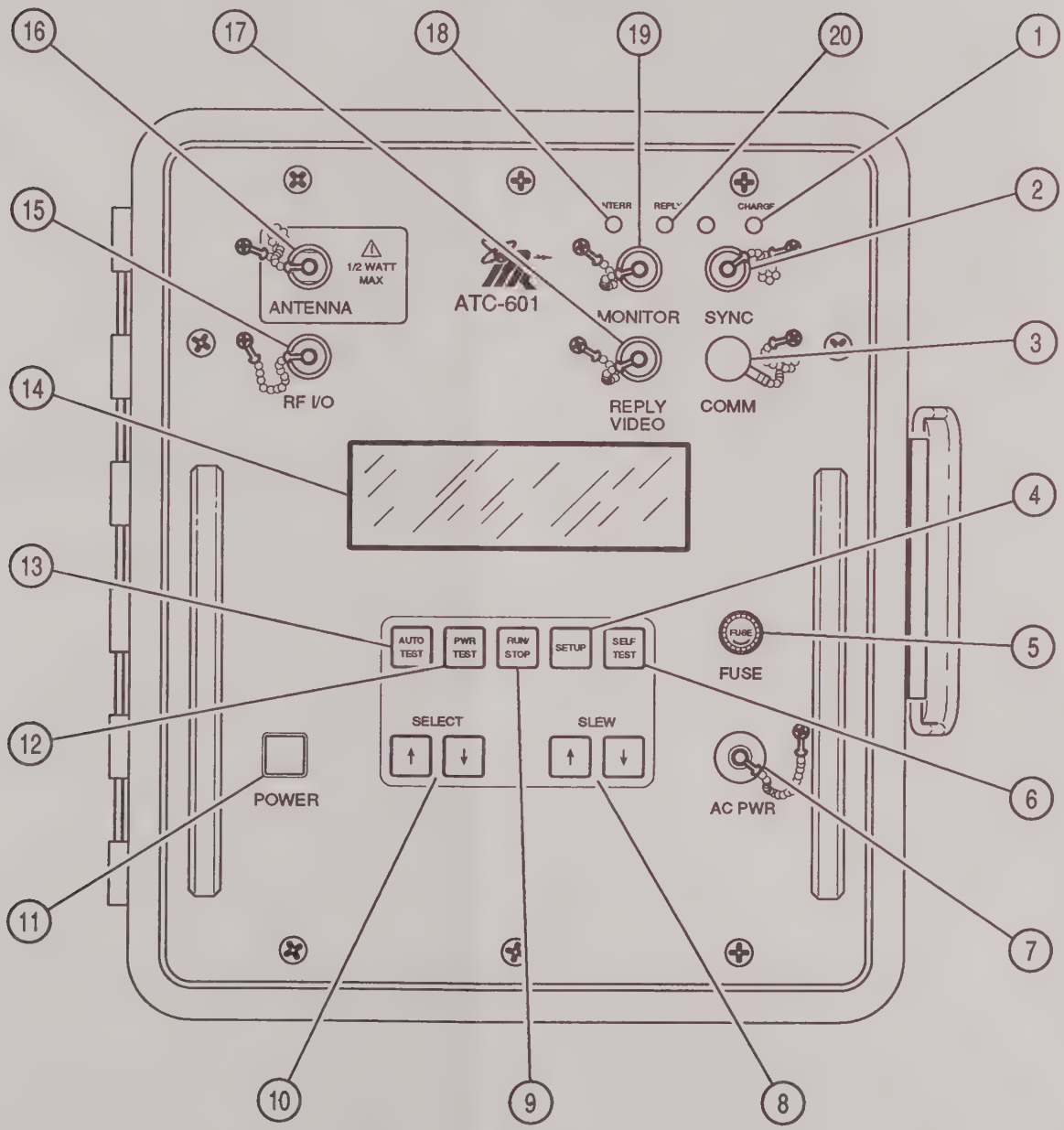
G. Bench Operation

Unless specified otherwise, refer to 1-2-2, Figure 2 for Controls, Connectors and Indicators used in preparing Test Set for bench operation.

STEP	PROCEDURE

1. Place transponder (unit under test [UUT]) into Standby.
2. Remove cover from AC PWR Connector (7) on ATC-601.
3. Refer to 1-2-1, Figure 1. If power source is 103.5-129 VAC, set Line Supply Switch to 115. If power source is 207-253 VAC, set Line Supply Switch to 230.
4. Connect ac power source to AC PWR Connector (7) using AC Power Cable.
5. Press POWER Key (11) to On and verify DISPLAY (14) is illuminated.
6. Press SETUP Key (4) and select zero range using SELECT Keys (10) for item and SLEW Keys (8) for value.
7. Verify ANTENNA Connector (16) has 50 Ω load (Connector Cover) connected.
8. Connect UUT with TNC Cable to RF I/O Connector (15).
9. Switch UUT out of Standby.

2. Description of Controls, Connectors and Indicators



ATC-601 Front Panel
Figure 2

1. CHARGE Indicator
2. SYNC Connector (J10055)
3. COMM Connector J10053)
4. SETUP Key
5. FUSE
6. SELF TEST Key
7. AC PWR Connector (J10050)
8. SLEW Keys
9. RUN/STOP Key
10. SELECT Keys
11. POWER Key
12. PWR TEST Key
13. AUTO TEST Key
14. DISPLAY
15. RF I/O Connector (J10058)
16. ANTENNA Connector (J10057)
17. REPLY VIDEO Connector (J10054)
18. INTERR Indicator
19. MONITOR Connector (J10056)
20. REPLY Indicator

A. Front Panel (Refer to 1-2-2, Figure 2.)

ITEM	DESCRIPTION

1. CHARGE Indicator

   LED indicates the charger is active (ac applied with Test Set Off). Red indicates when battery is charging and green indicates battery is more than 80% charged.

2. SYNC Connector (J10055)

   BNC type connector providing Oscilloscope Sync. Long pulse goes from low to high before an interrogation and from high to low before an expected reply.

3. COMM Connector (J10053)

   LEMO type connector used for 4-line serial communication and includes the signals TRANSMIT, RECEIVE, DTR and CTS (refer to COMM Connector Pinout Table, Appendix A).

4. SETUP Key

   Enters Setup Menu onto the DISPLAY (14) and allows user to edit different parameters needed for power measurements.

5. FUSE

   1.0 Amp, 250 V Fast-Blo.

6. SELF TEST Key

   Enters Self Test screen onto DISPLAY (14).

7. AC PWR Connector (J10050)

   Used for connecting an external electrical power source for recharging the battery or operating the Test Set.

8. SLEW Keys

   Used to:

   - Adjust values in Setup Menu.
   - Select Signal Type in Diagnostics Test menu.
   - Adjust values in Diagnostics Test menu.
   - Select antenna to be tested in Power Test.

   Variable slew rates are available, depending on item being edited. Keeping SLEW Key pressed provides greater rate of change, in most instances, than pressing and releasing.

ITEM DESCRIPTION

9. RUN/STOP Key

   Used to start or stop testing.

10. SELECT Keys

    Used to select:

    - Test to perform in Single Test.
    - Item to edit in Setup Menu.
    - Antenna to be tested in Power Test.
    - Diagnostics Test menu from Self Test screen.

11. POWER Key

    Applies power to Test Set.

    NOTE: When operating on battery power, an internal automatic time-out removes power from the Test Set following 15 minutes of no key activity.

12. PWR TEST Key

    Enters Power Test screen onto DISPLAY (14).

13. AUTO TEST Key

    Enters Auto Test screen onto DISPLAY (14).

14. DISPLAY

    LCD readout displays various test screens.

15. RF I/O Connector (J10058)

    TNC type connector used for RF input and output. Direct connection with UUT is accomplished through this connector.

16. ANTENNA Connector (J10057)

    BNC type connector used with Test Set Antenna (Flat Antenna or Monopole Antenna). Over-the-air testing of the UUT is accomplished through this connector. The Connector Cover, when attached, provides the 50 Ω load required when direct connection with UUT is used or when Self Test is run.

17. REPLY VIDEO Connector (J10054)

    BNC type connector providing demodulated (detected) reply (only when direct connection with UUT is used) for use with an Oscilloscope.

ITEM	DESCRIPTION

18. INTERR Indicator

    Illuminates when Test Set is generating an interrogation signal.

19. MONITOR Connector (J10056)

    BNC type connector providing interrogation and reply pulses clipped at 50% amplitude point to preserve pulse shape.

20. REPLY Indicator

    Illuminates when Test Set receives a valid reply signal.

B. Flat Antenna (Refer to 1-2-2, Figures 2 and 3.)

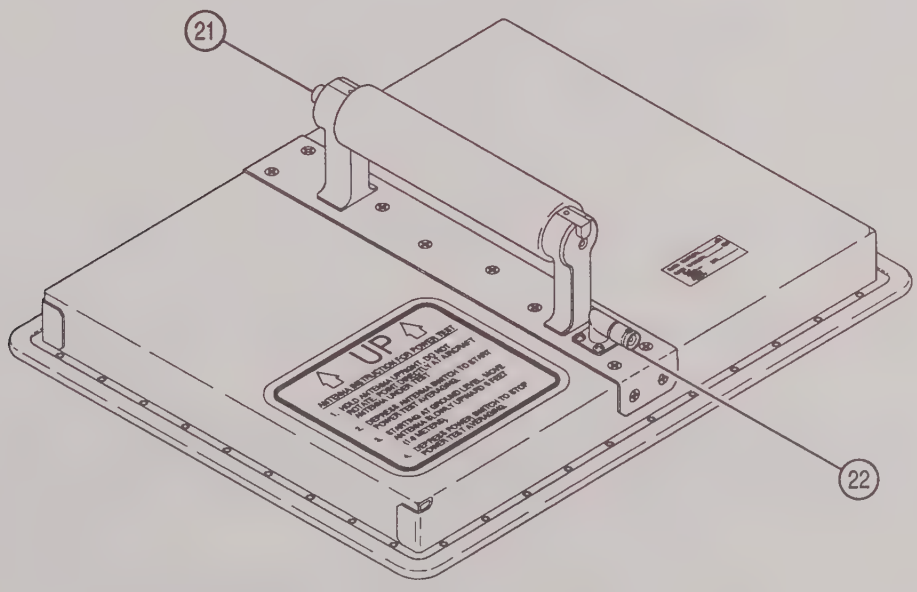
ITEM	DESCRIPTION

21. ANTENNA PUSH BUTTON Switch

    Used to start or stop testing, same as RUN/STOP Key (9).

22. FLAT ANTENNA Connector (J29001)

    BNC type connector used to connect Flat Antenna to ATC-601 Test Set.



Flat Antenna
Figure 3

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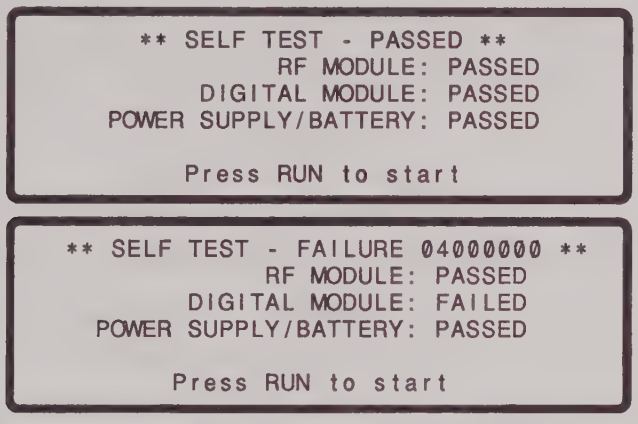
3. Performance Evaluation

A. General

The ATC-601 is equipped with a Self Test for quick performance evaluation and Diagnostics for signal verification. Self Test checks the Digital Module (Digital IF PC Board Assembly and Front Panel Pulse PC Board Assembly functions), Power Supply/Battery and RF Module (RF Assembly functions) for operational capability. Diagnostics are used to verify the ATC-601 is transmitting correct interrogations and accurately decoding replies.

Refer to 1-2-2, Figure 2 for the location of the Controls, Connectors, and Indicators.

B. Self Test (Refer to 1-2-3, Figure 4.)



Sample Self Test Screens
Figure 4

STEP	PROCEDURE

1. Press POWER Key (11).

2. Press SELF TEST Key (6) to enter Self Test screen. Results of last Self Test are displayed.

3. Press RUN/STOP Key (9) to initiate Self Test. A "PASSED" or "FAILURE" indication is displayed. Test names are displayed in top line while test is in progress. An eight-digit hexadecimal error code is displayed with any failure indication. Also, a "PASSED" or "FAILED" indication is displayed for each module.

4. Verify all modules/assemblies passed test.

   NOTE: If a failure is indicated, refer to 1-2-3, Table 1 for error code definitions. If the battery is failing, refer to 1-2-1F for Battery Recharging. If any other failure occurs, refer to ATC-601 Maintenance Manual for further testing and maintenance instructions.

TEST	GROUP	VERIFIES	FAILURE CODE (h)	RUNNING ORDER
LO Control	RF	Valid ON/OFF status	00000001	2
LO Detect	RF	LO is locked.	00000002	16
RF Detect	RF	TX level out/attenuation	00000004	17
Battery	Power Supply/ Battery	Voltage is within correct voltage range.	00000010	1
Non-Volatile RAM Battery	Power Supply/ Battery	Battery has sufficient power for RAM to retain memory.	00000020	Only on power-up
DSP Initialization	Digital	Handshake routine	00000040	18
Reply Decoder	Digital	Solicited ATCRBS reply	00000100	10
		Solicited Mode S reply	00000200	9
		Unsolicited Mode S reply (squitter)	00000400	8
IF Loop	RF	Background level (0 dB)	00020000	19
		SLS/ foreground (9 dB)	00100000	20
		DSP does not measure a non-existent signal.	00200000	21
UART	Digital	RS-232 loop back	00400000	12
Pulse Wrap	Digital	PULSE to DPSK timing	00800000	11
RAM	Digital	Dual Port RAM (DPR)	01000000	3
		Video RAM	02000000	4
		Non-Volatile RAM	04000000	6
		Display RAM	08000000	5
Attenuator #1	Digital	Level at endline diodes	10000000	13
Attenuator #2	Digital	Level at midline diodes	20000000	13
LO Compensation	Digital	DCXO control voltage	40000000	15
LED	Digital	Interrogation and reply drivers	80000000	7

NOTE: Multiple failures are indicated by the sum of the error codes.
NOTE: If DPR Test fails, Video RAM Test and subsequent tests are not run.

Self Test Error Code Definitions
Table 1

C. Diagnostics (Refer to 1-2-3, Figure 5.)

```
            ** DIAGNOSTICS **
SIGNAL TYPE: ATC_C          PRF: 235
ATTENUATION: 50          ADDRESS: 3FABF2
DATA: 0050 01
INTERROGATIONS: 20     FAILURES: 0
            Press RUN to start
```

Sample Diagnostics Screen
Figure 5

CAUTION: DO NOT OPERATE DIAGNOSTICS WITH ANTENNA CONNECTED TO ATC-601 TEST SET. TRANSMISSION SIGNALS USED IN DIAGNOSTICS MAY INTERFERE WITH OTHER AREA TRANSPONDER OPERATION AND/OR VIOLATE FCC RULES AND REGULATIONS, PART 87, GOVERNING SIGNAL TRANSMISSIONS FOR LAND TEST STATIONS.

STEP	PROCEDURE

1. Press SELF TEST Key (6) to enter Self Test screen.
2. Press either of the SELECT Keys (10) to enter Diagnostics Test screen.
3. Connect a transponder or reply generator to RF I/O Connector (15), for testing ATC-601 reply decoder.

   NOTE: Interrogation generation may be tested by running Diagnostics Test with or without connecting anything to the ATC-601 Test Set.

4. Use SLEW Keys (8) to change values or signal type. Use SELECT Keys (10) to change items. Cursor line indicates item selected.

Signal Type:	Interrogation signal transmitted by ATC-601 Test Set. This is same as interrogation sent in Auto and applicable Single Tests. Refer to 1-2-3, Table 2 for choice of signals.
PRF:	Interrogation rate from 1 to 235 interrogations per second. Mode S signals are limited to a PRF of 78. Selectable PRFs (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 20, 21, 24, 26, 29, 34, 39, 47,59, 78, 118 or 235) are rounded quotients of 235 divided by whole numbers.
Attenuation:	Attenuation of incoming signal/ATC-601 output from 0 to 100 steps with each step representing 0.5 dB (0 = no attenuation).
Address:	Address sent in Mode S interrogations. Address is changeable in three separate sections, each ranging from 00 to FF (hexadecimal).

STEP PROCEDURE

5. Press RUN/STOP Key (9) to initiate test. Information is displayed as follows:

Data: Most recent reply information in hexadecimal form. Refer to Appendix C for reply definition. Data field is followed by a two-digit, hexadecimal status byte. Only the least significant digit (LSD) is used. Status definition is:

For ATCRBS, LSD is:
0, 2, 4, 6, 8, A, C or E = Unsolicited reply.
1, 3, 5, 7, 9, B, D or F = Solicited reply.

For Mode S, LSD is:
0, 4, 8 or C = Invalid, Unsolicited reply.
1, 5, 9 or D = Valid, Unsolicited reply.
2, 6, A or E = Invalid, Solicited reply.
3, 7, B or F = Valid, Solicited reply.

Interrogations: Number of interrogations transmitted.

Failures: Number of interrogations for which no reply was received.

6. Press RUN/STOP Key (9) to stop test.

SIGNAL TYPE	DEFINITION	USED IN
DSP_MEASURE	(not a signal) DSP testing	ATC-601 Calibration
CW_M5	Continuous Wave at -5 dB	ATC-601 Calibration
CW	Continuous Wave at 0 dB (power level compensates to attenuation)	ATC-601 Calibration
CW_P4	Continuous Wave at +4 dB	ATC-601 Calibration
ATC_A_BCKGND	ATCRBS Mode A (background level)	Test operations for automatic attenuation control
ATC_C_BCKGND	ATCRBS Mode C (background level)	MTL Difference Test
ITM_MODES_C	Intermode (Mode C/S)	ATCRBS/Mode S All-Call

Diagnostics Signal Definitions
Table 2

SIGNAL TYPE	DEFINITION	USED IN
ITM_MODES_A	Intermode (Mode A/S)	ATCRBS/Mode S All-Call
ITM_ATC_C	Intermode (Mode C)	ATCRBS Only All-Call
ITM_ATC_A_S	Intermode (Mode A) (triggered to detect Mode S)	ATCRBS Only All-Call
ITM_ATC_A	Intermode (Mode A) (triggered to detect ATCRBS)	ATCRBS Only All-Call
ATC_C_SLS	Mode C with P_2 SLS	ATCRBS (SLS at -9 dB)
ATC_A_SLS	Mode A with P_2 SLS	ATCRBS (SLS at -9 dB)
ATC_C_SLSØDB	Mode C with P_2 SLS	ATCRBS (SLS at 0 dB)
ATC_A_SLSØDB	Mode A with P_2 SLS	ATCRBS (SLS at 0 dB)
ATC_C	Mode C	ATCRBS
ATC_A	Mode A	ATCRBS
FMT21	Uplink Format 21	Mode S
FMT20	Uplink Format 20	Mode S
FMT16	Uplink Format 16	Mode S
FMT11	Uplink Format 11	Mode S Only All-Call
FMT5	Uplink Format 5	Mode S
FMT4_SPR_OFF	Uplink Format 4 with Synchronous Phase Reversal (SPR) off	Mode S
FMT4_SPR_ON	Uplink Format 4 with SPR on	Mode S
FMTØ	Uplink Format 0	Mode S

Diagnostics Signal Definitions
Table 2 (Cont)

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4. General Operating Procedures

This section contains operating instructions for the ATC-601 Ramp Test Set. The operating instructions contain general procedures, identifying the Controls, Connectors, Indicators and Display screens used for the individual ATC-601 test functions. For specific UUT Procedures, refer to the appropriate UUT Manual.

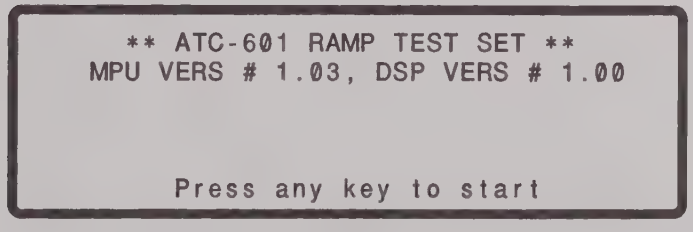
Refer to 1-2-2, Figure 2 for location of Controls, Connectors and Indicators called out in this section.

The purpose of the ATC-601 Ramp Test Set is to test the operation and installation of an ATCRBS or Mode S transponder in a ramp environment. There are four basic functions that allow the Test Set to do this:

- Setup allows operator to enter information into various parameters used for the different tests.
- Auto Test runs through a group of tests checking function and operation of the transponder.
- Single Test allows the user to run through any one of 19 individual tests.
- Power Test accurately measures Peak Pulse Power (Effective Radiated Power [ERP]) and Receiver Sensitivity (Minimum Triggering Level [MTL]) of the transponder, even when direct connection with UUT is not possible.

A. Start-up

Pressing the ATC-601 Test Set POWER Key (11) causes a Start-up screen to appear on the DISPLAY (14). Information contained in this screen indicates software versions of the Microprocessing Unit (MPU) and Digital Signal Processor (DSP) used in that particular Test Set.



Start-up Screen
Figure 6

B. Setup Menu

```
            ** SETUP MENU **
   UUT ANTENNA: RANGE HEIGHT
           TOP =   110     18
        BOTTOM =    45      8
      SELECTED =  BOTTOM
GAIN_1030=11.5 GAIN_1090=12.0 LOSS=1.0
```

```
            ** SETUP MENU **
   UUT ANTENNA: RANGE HEIGHT
           TOP =   110     18
        BOTTOM =    45      8
      SELECTED =  TOP
GAIN_1030=11.5 GAIN_1090=12.0 LOSS=1.0
```

```
            ** SETUP MENU **
   UUT ANTENNA: RANGE HEIGHT
           TOP =   250     18  **ERROR**
        BOTTOM =    45      8
      SELECTED =  TOP
GAIN_1030=11.5 GAIN_1090=12.0 LOSS=1.0
```

Sample Setup Menu Screens
Figure 7

The Setup Menu contains parameters used to accurately calculate various test results. Range established in the Setup is actual range used for Auto, Single (reply delay) and Power Test measurements.

NOTE: Enter Setup information before conducting test operations.

Unless otherwise specified, refer to 1-2-4, Figure 7.

STEP	PROCEDURE

1. Position ATC-601 Test Set according to 1-2-4, Figure 8.

   NOTE: For best Power Test results, aircraft, buildings, vehicles and other large objects should not be between Test Set and aircraft with Unit Under Test (UUT). Refer to 1-2-4, Figure 30.

2. Press SETUP Key (4) to enter Setup Menu. Information from last Setup Menu is displayed.

3. Enter information using SLEW Keys (8) to change values and SELECT Keys (10) to change items. Cursor line indicates item selected.

   NOTE: The SLEW Keys (8) have different rates of change according to item and the way keys are pressed. Press and release a key to change a value by one foot. Press and hold a key to change Range values in ten foot increments and Height values in five foot increments.

STEP PROCEDURE

RANGE: Ground distance from ATC-601 to UUT Antenna, in feet. If ATC-601 is not within effective range per Figure 8, an error is indicated on DISPLAY (14). Zero Range indicates direct connection.

HEIGHT: Distance from ground to UUT Antenna, in feet.

SELECTED: UUT Antenna tested in Auto, Single and Power Tests. Selection determines which set of Range and Height values are used for Auto, Single and Power Test calculations.

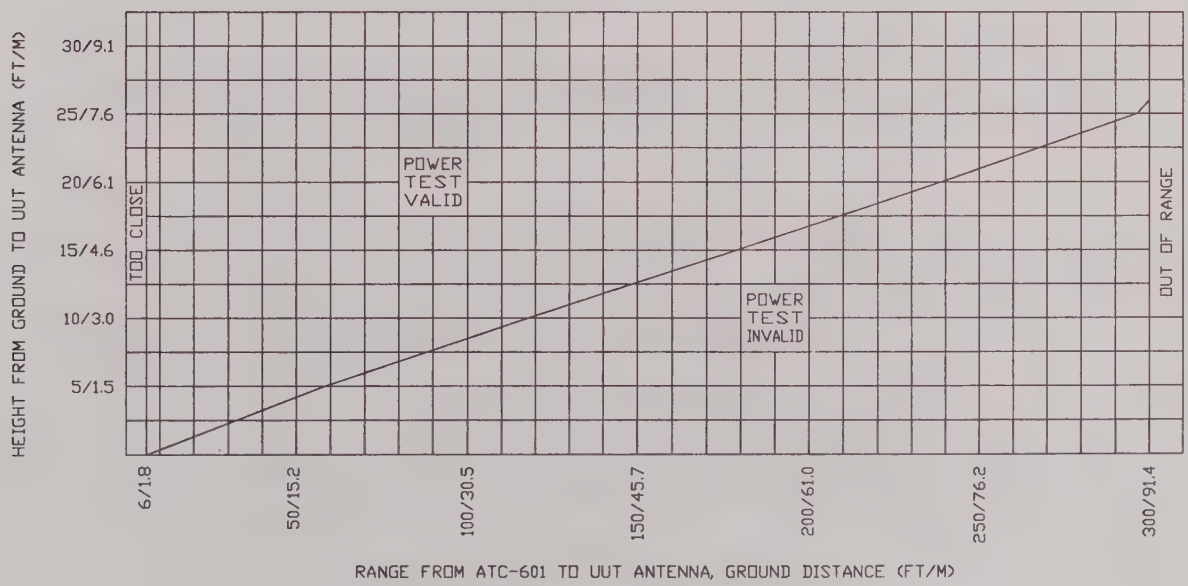
NOTE: Actual UUT Antenna tested depends upon shielding or disconnecting the UUT Antenna not being tested.

GAIN 1030/GAIN 1090: Gain in dBi, of Test Set antenna at 1030 MHz and 1090 MHz frequencies (noted on Flat Antenna).

LOSS: Coaxial Cable Loss in dB, of ATC-601 antenna or direct connect cable (noted on coax tag).

4. Use SLEW Keys (8) to select UUT Antenna to be tested in the Auto, Single and Power Tests.

5. Press SETUP Key (4) to exit Setup Menu.



ATC-601 Position Chart
Figure 8

C. Auto Test

(1) Description

The Auto Test determines operational transponder modes (A, C and/or S). The Test Set interrogates at a level 4 dB above MTL. Auto Test runs through the following 21 tests:

TEST	DESCRIPTION

0. Mode Test

Identifies modes of operation. Interrogations are made in Modes A, C and S (uplink format 11) to determine which modes the transponder replies to. These are the modes tested during the Auto Test sequence.

1. Reply Delay

Interrogates with valid modes and verifies reply delay minus range delay (average of best 8 of 13 replies) equals:

- 128.00 µs (±0.25 µs) for Mode S.
- 128.00 µs (±0.50 µs) for Intermode (All-Call)
- 3.00 µs (±0.50 µs) for ATCRBS.

NOTE: Range delay is 2.03 ns/ft (6.67 ns/m), calculated from the values in the Setup Menu.

2. Reply Jitter

Interrogates with valid modes and verifies, using best 24 of 39 replies, reply jitter (changes in reply delay) is less than or equal to:

- 0.08 µs for Mode S.
- 0.10 µs for Intermode (All-Call) and ATCRBS.

3. ATCRBS Reply

Interrogates with ATCRBS (Modes A and C) interrogations and verifies:

- F_1 to F_2 spacing is 20.3 µs (±0.10 µs).
- F_1 and F_2 pulse width between the 0.5 amplitude points on the leading and trailing edge is 0.45 µs (±0.10 µs).

TEST DESCRIPTION

4. SLS Level

NOTE: Because interrogation with SLS at -9 dB is sent at MTL plus 12 dB, SLS Test must be run within 95 feet (28.96 meters) of UUT Antenna being tested.

Interrogates with valid ATCRBS interrogations including P_2 pulse. Interrogations are conducted with P_2 level at -9 dB and then again at 0 dB. Test verifies:

- Transponder does not reply when P_2 level is at 0 dB (UUT is suppressed).
- Transponder replies when P_2 level is at -9 dB (UUT is not suppressed).

5. ATCRBS Only All-Call

Interrogates with an ATCRBS only All-Call and verifies Mode S transponders do not reply.

6. Mode S All-Call

Interrogates with the ATCRBS (Mode A)/Mode S All-Call. Address received in Downlink Format (DF) 11 is then used in an Uplink Format (UF) 4 interrogation to solicit a DF4 reply. The address received is decoded and compared with the address sent.

7. Invalid Mode S Address

Transmits Mode S interrogations using two addresses different from the address determined by the Mode S All-Call, UF11. Test verifies no reply is received. Addresses used are one greater and 256 greater than the correct address.

8. SPR On/Off

Transmits a Mode S interrogation with the Synchronous Phase Reversal (SPR) On, verifying correct reply is received. Then same interrogation is sent again with the SPR Off, verifying no reply is received.

9. Mode S UF0

Interrogates with Mode S Uplink Format 0 (Short air to air surveillance, ACAS) verifying reply is received that has correct altitude (compared with Mode C altitude), address (compared with Mode Test address) and format.

TEST DESCRIPTION

10. Mode S UF4

    Interrogates with Mode S UF4 (Surveillance, altitude request), verifying reply is received that has correct altitude (compared with Mode C altitude), address (compared with Mode Test address) and format.

11. Mode S UF5

    Interrogates with Mode S UF5 (Surveillance, identity request) verifying reply is received that has correct identity (compared with Mode A identity), address (compared with Mode Test address) and format.

12. Mode S UF11

    Interrogates with Mode S UF11, verifying reply is received that has correct address (compared with Mode Test address) and format.

13. Mode S UF16

    Interrogates with Mode S UF16 (Long air to air surveillance, ACAS), verifying reply, if received, has correct altitude (compared with Mode C altitude), address (compared with Mode Test address) and format. No reply to UF16 does not fail Mode S in Auto Test.

14. Mode S UF20

    Interrogates with Mode S UF20 (Comm A, altitude request) verifying reply received has correct altitude (compared with Mode C altitude), address (compared with Mode Test address) and format. No reply to UF20 does not fail Mode S in Auto Test.

15. Mode S UF21

    Interrogates with Mode S UF21 (Comm A, identity request) verifying reply received has correct identity (compared with Mode A identity), address (compared with Mode Test address) and format. No reply to UF21 does not fail Mode S in Auto Test.

16. Squitter

    Verifies squitters are being received from the UUT every 0.8 to 2.4 seconds.

17. Frequency

    Verifies frequency of transponder is 1090 MHz (±3 MHz). Frequency is displayed in the Auto Test screen.

TEST	DESCRIPTION

18. Diversity

    Verifies diversity isolation (power level difference between UUT "On" antenna squitters and "Off" antenna squitters) is greater than or equal to 20 dB. Diversity isolation is displayed in Auto Test screen.

    NOTE: To insure ≥ 20 dB dynamic range, test must be run within 50 feet (15.24 meters) of UUT Antenna being tested.

19. MTL Difference

    Verifies MTL to Mode A interrogations equals MTL to Mode C interrogations (±1.0 dB).

20. Power

    NOTE: A special procedure (refer to 1-2-4E) to reduce the affects of multipath is used to measure power over the air.

    Verifies transponder:

    - ERP is greater than 48.5 dBm and less than 57.0 dBm.
    - MTL is -73.0 dBm (±4.0 dBm).

(2) General Procedure (Refer to 1-2-4, Figure 9.)

STEP	PROCEDURE

1. Connect UUT to ATC-601 RF I/O Connector (15) for direct connection or connect a Test Set Antenna to ATC-601 ANTENNA Connector (16). Have Test Set Antenna facing UUT Antenna at Setup Range.

   NOTE: If direct connection is not used, either shield with Antenna Shield (refer to Appendix D) or disconnect and terminate UUT Antenna not being tested. Other area transponders must also be deactivated or located at least three times the Setup Range from the Test Set Antenna.

2. Press AUTO TEST Key (13) to enter Auto Test screen. Results of last Auto Test are shown on DISPLAY (14).

3. Press RUN/STOP Key (9) or ANTENNA PUSH BUTTON Switch (21) (if Flat Antenna is being used) to run Auto Test. "TEST RUNNING" and asterisks in bottom line of DISPLAY (14) indicate test is running.

4. Press RUN/STOP Key (9) or ANTENNA PUSH BUTTON Switch (21) (if Flat Antenna is being used) at any time to stop test (non-resumable). Otherwise, Auto Test runs until all tests are complete. DISPLAY (14) indicates which modes (A, C and/or S) were tested, which modes passed and which modes failed. UUT frequency, power measurements and diversity isolation are also displayed.

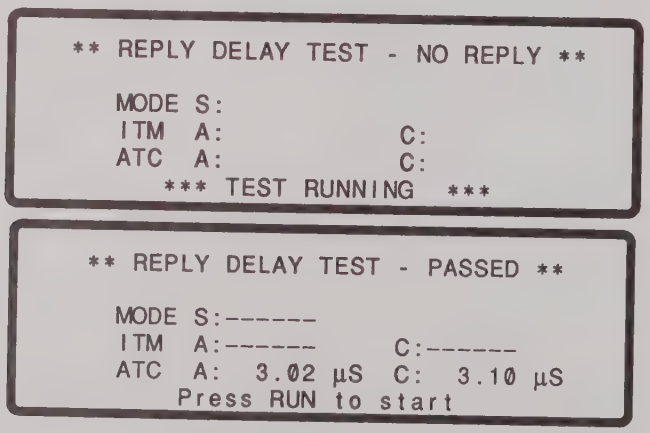
Symbol	Location	Indicates
****	Power Values Line	Variance due to excessive multipath
** TEST RUNNING **	Bottom line	Test is running
[ ]	ATCRBS Altitude line Squitter Address line Mode S All-Call Address line	Data in Octal form
.	Before Power Test line	UUT Antenna selected
■■	Left Side, Below Bottom Line	Battery is Low

Screen Symbols Identification Chart
Table 3 (Cont)

TEST DESCRIPTION

1. Reply Delay (Refer to 1-2-4, Figure 10.)

Interrogates with Modes A, C, S and ATCRBS/Mode S All-Call (Intermode [ITM]); verifying reply delay minus range delay is 128 µs (±0.25 µs) for Mode S, 128 µs (±0.50 µs) for ITM and 3.00 µs (±0.50 µs) for ATCRBS modes. Range delay is 2.03 ns/ft (6.67 ns/m) and is calculated using range values established in the Setup Menu. Reply delay times are indicated on the DISPLAY (14). Only Mode S is looked at with ITM interrogation.


** REPLY DELAY TEST - NO REPLY **
MODE S:
ITM A: C:
ATC A: C:
*** TEST RUNNING ***
** REPLY DELAY TEST - PASSED **
MODE S:------
ITM A:------ C:------
ATC A: 3.02 µS C: 3.10 µS
Press RUN to start

Sample Reply Delay Test Screens
Figure 10

```
** REPLY DELAY TEST - FAILED **

MODE→S:129.05 µS
ITM  A:128.02 µS  C:128.04 µS
ATC  A:  3.02 µS  C:  3.10 µS
     Press RUN to start
```

Sample Reply Delay Test Screens
Figure 10 (Cont)

2. Reply Jitter (Refer to 1-2-4, Figure 11.)

   Interrogates with Modes A, C, S and ATCRBS/Mode S All-Call (ITM); verifying reply jitter is ≤0.08 µs for Mode S and ≤0.1 µs for ATCRBS and ITM modes. Reply jitter values (difference between shortest and longest reply) are indicated on DISPLAY (14).

```
** REPLY JITTER TEST - NO REPLY **

MODE S:
ITM  A:              C:
ATC  A:              C:
   *** TEST RUNNING  ***
```

```
** REPLY JITTER TEST - PASSED **

MODE S: 0.030 µS
ITM  A: 0.050 µS  C: 0.050 µS
ATC  A: 0.100 µS  C: 0.075 µS
     Press RUN to start
```

```
** REPLY JITTER TEST - FAILED **

MODE→S: 0.130 µS
ITM  A: 0.050 µS  C: 0.050 µS
ATC  A: 0.100 µS  C: 0.075 µS
     Press RUN to start
```

Sample Reply Jitter Test Screens
Figure 11

3. ATCRBS Reply (Refer to 1-2-4, Figure 12.)

Interrogates with Modes A and C, verifying F_1 to F_2 spacing is 20.3 µs (±0.10 µs) and F_1/F_2 pulse widths are 0.45 µs (±0.10 µs). F_1 to F_2 spacing, F_1 width and F_2 width values are indicated on DISPLAY (14). Mode A Identity (ID) Code and Mode C altitude are also displayed. If Special Position Identification Pulse (SPI) is present, "ID" is displayed before Mode A Code. ALT field blanks out if invalid input (no C bit or C_1 and C_4 are on at the same time) is received. The 4-digit octal code, shown regardless of validity, displays the Mode C information as follows (MSD to LSD): $A_4,A_2,A_1/B_4,B_2,B_1/C_4,C_2,C_1/D_4,D_2,D_1$.

```
  ** ATCRBS REPLY TEST - NO REPLY **
F1 TO F2 SPACING A:           C:
F1 PULSE WIDTH   A:           C:
F2 PULSE WIDTH   A:           C:
CODE=            ALT=
          *** TEST RUNNING ***
```

```
    ** ATCRBS REPLY TEST - PASSED **
F1 TO F2 SPACING A:20.30 µS  C:20.30 µS
F1 PULSE WIDTH   A: 0.45 µS  C: 0.45 µS
F2 PULSE WIDTH   A: 0.45 µS  C: 0.45 µS
CODE=  7777      ALT= 10,700 FT [6140]
          Press RUN to start
```

```
    ** ATCRBS REPLY TEST - FAILED **
F1 TO F2 SPACING→A:22.00 µS  C:20.30 µS
F1 PULSE WIDTH   A: 0.45 µS  C: 0.45 µS
F2 PULSE WIDTH   A: 0.45 µS  C: 0.45 µS
CODE=  7777      ALT= 10,700 FT [6140]
          Press RUN to start
```

Sample ATCRBS Reply Test Screens
Figure 12

4. SLS Level (Refer to 1-2-4, Figure 13.)

Interrogates with ATCRBS Modes A and C interrogations including the P_2 SLS pulse, verifying valid replies are received when P_2 level is set at -9 dB and no reply is received when P_2 level is set at 0 dB. Results are indicated on DISPLAY (14).

NOTE: Because interrogation with SLS at -9 dB is sent at MTL + 12 dB, SLS Test must be run within 95 feet (28.96 meters) of UUT Antenna being tested.

```
** SLS LEVEL TEST - PASSED **

-9 dB: REPLY
 0 dB: NO REPLY

Press RUN to start
```

```
** SLS LEVEL TEST - PASSED **

 -9 dB: REPLY
→ 0 dB: REPLY

Press RUN to start
```

```
** SLS LEVEL TEST - FAILED **

→-9 dB: NO REPLY
  0 dB: NO REPLY

Press RUN to start
```

Sample SLS Level Test Screens
Figure 13

5. ATCRBS Only All-Call (Refer to 1-2-4 Figure 14.)

   Interrogates with an ATCRBS only All-Call and verifies no reply is received from Mode S transponders. DISPLAY (14) indicates results.

```
** ATC ONLY ALL-CALL TEST - PASSED **

PASSED TEST

Press RUN to start
```

```
** ATC ONLY ALL-CALL TEST - FAILED **

MODE S XPDR REPLIED WITH ATCRBS

Press RUN to start
```

Sample ATCRBS Only All-Call Test Screens
Figure 14

```
** ATC ONLY ALL-CALL TEST - NO REPLY**


          Press RUN to start
```

```
** ATC ONLY ALL-CALL TEST - FAILED **

   MODE S XPDR REPLIED WITH MODE S

          Press RUN to start
```

Sample ATCRBS Only All-Call Test Screens
Figure 14 (Cont)

6. Mode S All-Call Test (Refer to 1-2-4, Figure 15.)

   Interrogates with the ATCRBS (Mode A)/Mode S All-Call and displays the DF11 reply address. This address is then sent in a UF4 interrogation. The DF4 reply address is indicated on DISPLAY (14) and compared with the one used. Test fails if Mode S reply is not received or address is inconsistent.

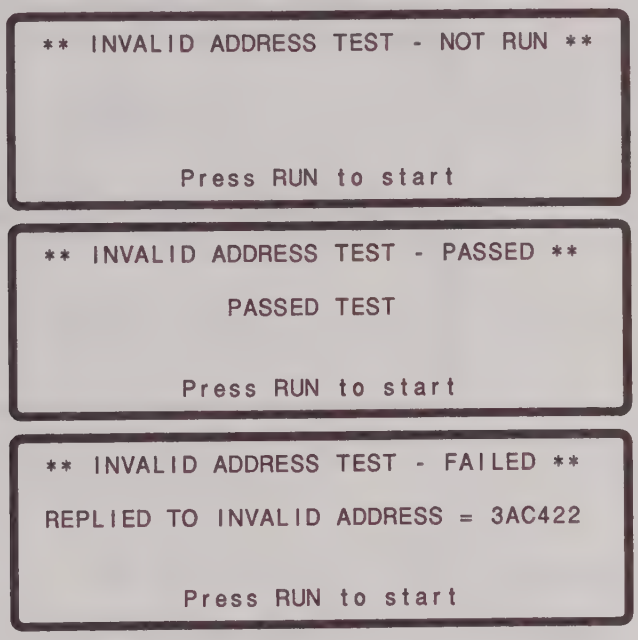
```
** MODE S ALL-CALL TEST - PASSED **
ALL-CALL ADDRESS = 3AC421 [16542041]
TAIL NUMBER      = N12345


          Press RUN to start
```

```
** MODE S ALL-CALL TEST - FAILED **
ALL CALL ADDRESS = 3BD532 [16752462]
TAIL NUMBER      = N12345
DF4 REPLY ADDRESS= 3AC421

          Press RUN to start
```

Sample Mode S All-Call Test Screens
Figure 15

7. Invalid Mode S (Refer to 1-2-4, Figure 16.)

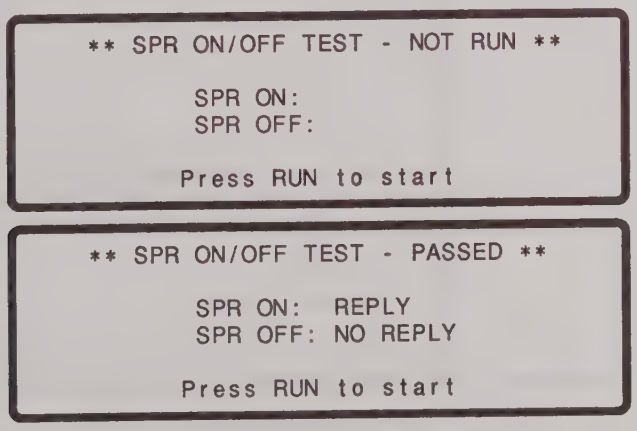
   Transmits Mode S interrogations using addresses different from the address determined by the Mode S All-Call (UF11) and verifies no reply is received. Results are indicated on DISPLAY (14).


** INVALID ADDRESS TEST - NOT RUN **
Press RUN to start
** INVALID ADDRESS TEST - PASSED **
PASSED TEST
Press RUN to start
** INVALID ADDRESS TEST - FAILED **
REPLIED TO INVALID ADDRESS = 3AC422
Press RUN to start

Sample Invalid Mode S Address Test Screens
Figure 16

8 SPR On/Off (Refer to 1-2-4, Figure 17.)

Interrogates with a Mode S interrogation with SPR On and indicates if reply is received. The same interrogation is sent again with SPR Off and test verifies no reply is received. Results are indicated on DISPLAY (14).


** SPR ON/OFF TEST - NOT RUN **
SPR ON:
SPR OFF:
Press RUN to start
** SPR ON/OFF TEST - PASSED **
SPR ON: REPLY
SPR OFF: NO REPLY
Press RUN to start

Sample SPR On/Off Test Screens
Figure 17

```
** SPR ON/OFF TEST - FAILED **

   SPR ON:  REPLY
→ SPR OFF: REPLY

Press RUN to start
```

```
** SPR ON/OFF TEST - FAILED **

→ SPR ON:  NO REPLY
  SPR OFF: NO REPLY

Press RUN to start
```

Sample SPR On/Off Test Screens
Figure 17 (Cont)

9. Mode S UF0 (Refer to 1-2-4, Figure 18.)

Interrogates with UF0 verifying a reply is received having correct altitude, same address and correct format. Altitude reported in DF0 is compared with altitude reported during Mode Test in valid ATCRBS Mode C reply. Address is compared with address reported during Mode Test in DF11 reply. Downlink Format Fields are indicated on DISPLAY (14). When test fails because of incorrect altitude, Mode C altitude is displayed. When test fails because of wrong address, DF11 address is displayed. UF0 AQ bit is "1" for requesting airspeed information in DF0 RI field.

NOTE: AC field blanks out if invalid data is received for that field.

```
** MODE S UF0 TEST - NO REPLY **

DF     VS=      RI=      AC=
ADDRESS=

**** TEST RUNNING ****
```

```
** MODE S UF0 TEST - PASSED **

DF 0   VS=1     RI=C     AC= 10,700 FT
ADDRESS=3AC421

Press RUN to start
```

Sample Mode S UF0 Test Screens
Figure 18

```
   ** MODE S UF0 TEST - FAILED **

 DF 0  VS=1     RI=C    →AC= 10,800 FT
 ADDRESS=3AC421
 MODE C ALT = 10,700 FT
         Press RUN to start
```

```
   ** MODE S UF0 TEST - FAILED **

 DF 0  VS=1     RI=C     AC= 10,700 FT
→ADDRESS=3BD432
 DF11 ADDR=3AC421
         Press RUN to start
```

```
   ** MODE S UF0 TEST - FAILED **

→DF 4  VS=1     RI=C     AC= 10,700 FT
 ADDRESS=3AC421

         Press RUN to start
```

Sample Mode S UF0 Test Screens
Figure 18 (Cont)

10. Mode S UF4 (Refer to 1-2-4, Figure 19.)

Interrogates with UF4 verifying a reply is received having correct altitude, same address and correct format. Altitude reported in DF4 (Surveillance, altitude reply) is compared with altitude reported during Mode Test in valid ATCRBS Mode C reply. Address is compared with address reported during Mode Test in DF11 reply. Downlink Format Fields are indicated on DISPLAY (14). When test fails because of incorrect altitude, Mode C altitude is displayed. When test fails because of wrong address, DF11 address is displayed.

NOTE: AC field blanks out if invalid data is received for that field.

```
   ** MODE S UF4 TEST - NO REPLY **

DF    FS=   DR=    UM=     AC=
ADDRESS=

        *** TEST RUNNING **
```

Sample Mode S UF4 Test Screens
Figure 19

```
** MODE S UF4 TEST - PASSED **

DF 4 FS=1 DR=00 UM=00  AC= 10,700 FT
ADDRESS=3AC421

Press RUN to start
```

```
** MODE S UF4 TEST - FAILED **

DF 4 FS=1 DR=00 UM=00 →AC= 10,800 FT
ADDRESS=3AC421
MODE C ALT = 10,700 FT
Press RUN to start
```

```
** MODE S UF4 TEST - FAILED **

DF 4 FS=1 DR=00 UM=00  AC= 10,700 FT
→ADDRESS=3AB352
DF11 ADDR=3AC421
Press RUN to start
```

```
** MODE S UF4 TEST - FAILED **

→DF 0 FS=1 DR=00 UM=10  AC= 10,700 FT
ADDRESS=3AC421

Press RUN to start
```

Sample Mode S UF4 Test Screens
Figure 19 (Cont)

11. Mode S UF5 (Refer to 1-2-4, Figure 20.)

Interrogates with UF5 verifying a reply is received having correct ID, same address and correct format. ID Code reported in DF5 (Surveillance, identity reply) is compared with ID Code reported during Mode Test in valid ATCRBS Mode A reply. Address is compared with address reported during Mode Test in DF11 reply. Downlink Format Fields are indicated on DISPLAY (14). When test fails because of incorrect ID Code, Mode A, ID Code is displayed. When test fails because of wrong address, DF11 address is displayed.

```
   ** MODE S UF5 TEST - NO REPLY **

DF    FS=   DR=    UM=      ID=
ADDRESS=

         *** TEST RUNNING ***
```

```
   ** MODE S UF5 TEST - PASSED **

DF 5 FS=1 DR=00 UM=00   ID=7777
ADDRESS=3AC421

          Press RUN to start
```

```
   ** MODE S UF5 TEST - FAILED **

DF 5 FS=1 DR=00 UM=00 →ID=7377
ADDRESS=3AC421
MODE A CODE=  7777
          Press RUN to start
```

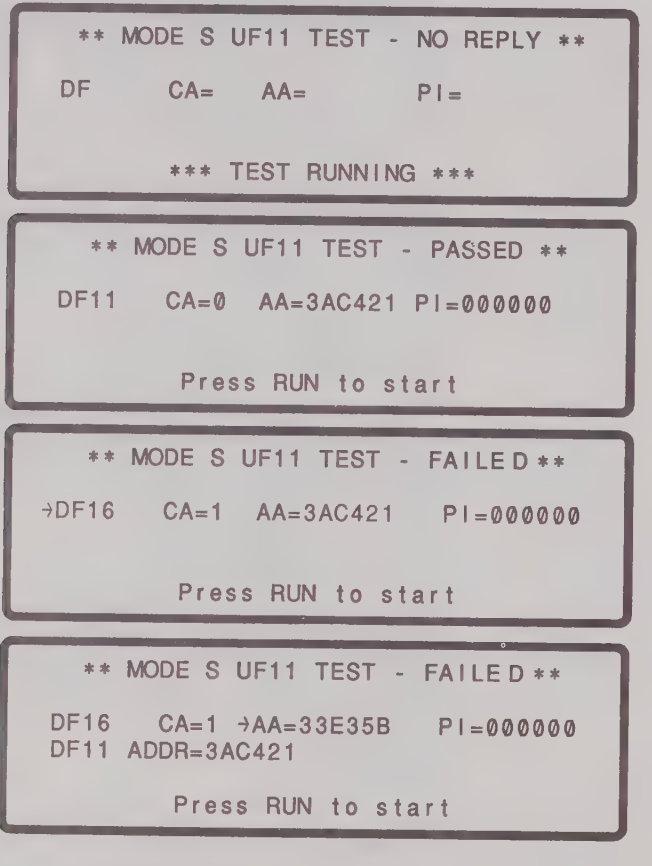
```
   ** MODE S UF5 TEST - FAILED **

 DF 5 FS=1 DR=00 UM=00   ID=7777
→ADDRESS=3BDE31
 DF11 ADDR=3AC421
          Press RUN to start
```

```
   ** MODE S UF5 TEST - FAILED **

→DF 0 FS=3 DR=12 UM=14   ID=3180
 ADDRESS=3AC421

          Press RUN to start
```

Sample Mode S UF5 Test Screens
Figure 20

12. Mode S UF11 (Refer to 1-2-4, Figure 21.)

Interrogates with UF11 verifying a reply is received having same address and correct format. Address is compared with address reported during Mode Test. Downlink Format Fields are indicated on DISPLAY (14). If test fails because of incorrect AA, Mode Test address is displayed.


** MODE S UF11 TEST - NO REPLY **
DF CA= AA= PI=
*** TEST RUNNING ***
** MODE S UF11 TEST - PASSED **
DF11 CA=0 AA=3AC421 PI=000000
Press RUN to start
** MODE S UF11 TEST - FAILED **
→DF16 CA=1 AA=3AC421 PI=000000
Press RUN to start
** MODE S UF11 TEST - FAILED **
DF16 CA=1 →AA=33E35B PI=000000
DF11 ADDR=3AC421
Press RUN to start

Sample Mode S UF11 Test Screens
Figure 21

13. Mode S UF16 (Refer to 1-2-4, Figure 22.)

Interrogates with UF16 verifying reply, if received, has correct altitude, same address and correct format. Altitude reported in DF16 is compared with altitude reported during Mode Test in valid ATCRBS Mode C reply. Address is compared with address reported during Mode Test in DF11 reply. Downlink Format Fields are indicated on DISPLAY (14). When test fails because of incorrect AC, Mode C altitude is displayed. When test fails because of wrong address, DF11 address is displayed. UF16 AQ bit is "0" for requesting TCAS capability information in DF16 RI field.

NOTE: AC field blanks out if invalid data is received for that field.

```
** MODE S UF16 TEST - PASSED **

DF16  VS=0      RI=0    AC= 10,700 FT
MV=00000000000000       ADDRESS=3AC421

        Press RUN to start
```

```
** MODE S UF16 TEST - FAILED **

DF16  VS=0      RI=0   →AC= 10,800 FT
MV=00000000000000       ADDRESS=3AC421
MODE C ALT= 10,700 FT
        Press RUN to start
```

```
** MODE S UF16 TEST - FAILED **

DF16   VS=0     RI=0    AC= 10,700 FT
MV=00000000000000      →ADDRESS=543212
DF11 ADDR=3AC421
        Press RUN to start
```

```
** MODE S UF16 TEST - FAILED **

→DF21  VS=0     RI=0    AC= 10,700 FT
 MV=00000000000000      ADDRESS=3AC421

        Press RUN to start
```

```
** MODE S UF16 TEST - NO REPLY **

DF      VS=     RI=     AC=
MV=                     ADDRESS=

        Press RUN to start
```

Sample Mode S UF16 Test Screens
Figure 22

14. Mode S UF20 (Refer to 1-2-4, Figure 23.)

Interrogates with UF20 verifying reply, if received, has correct altitude, same address and correct format. Altitude reported in DF20 (Comm B, altitude reply) is compared with altitude reported during Mode Test in DF11 reply. Downlink Format Fields are indicated on DISPLAY (14). When test fails because of incorrect AC, Mode C altitude is displayed. When test fails because of wrong address, DF11 address is displayed.

NOTE: AC field blanks out if invalid data is received for that field.

```
** MODE S UF20 TEST - PASSED **

DF20 FS=0  DR=00 UM=00 AC= 10,700 FT
MB=00000000000000       ADDRESS=3AC421

        Press RUN to start
```

```
** MODE S UF20 TEST - FAILED **

DF20 FS=0  DR=00 UM=00→AC= 10,800 FT
MB=00000000000000       ADDRESS=3AC421
MODE C ALT= 10,700 FT
        Press RUN to start
```

```
** MODE S UF20 TEST - FAILED **

DF20 FS=0  DR=00 UM=00 AC= 10,700 FT
MB=00000000000000      →ADDRESS=3BD422
DF11 ADDR=3AC421
        Press RUN to start
```

```
** MODE S UF20 TEST - FAILED **

→DF21 FS=0  DR=00 UM=00 AC= 10,700 FT
 MB=00000000000000       ADDRESS=3AC421

        Press RUN to start
```

```
** MODE S UF20 TEST - NO REPLY **

DF    FS=    DR=    UM=    AC=
MB=                        ADDRESS=

        Press RUN to start
```

Sampie Mode S UF20 Test Screens
Figure 23

15. Mode S UF21 (Refer to 1-2-4, Figure 24.)

Interrogates with UF21 verifying reply, if received, has correct ID, same address and correct format. !D Code reported in DF21 (Comm B, identity reply) is compared with ID Code reported during Mode Test in valid ATCRBS Mode A reply. Address is compared with address reported during Mode Test in DF11 reply. Downlink Format Fields are indicated on DISPLAY (14). When test fails because of incorrect ID Code, Mode A ID Code is displayed. When test fails because of wrong address, DF11 address is displayed.

```
** MODE S UF21 TEST - PASSED **

DF21 FS=0  DR=00 UM=00 ID=7777
MB=00000000000000      ADDRESS=3AC421

        Press RUN to start
```

```
** MODE S UF21 TEST - FAILED **

DF21 FS=0  DR=00 UM=00→ID=7377
MB=00000000000000      ADDRESS=3AC421
MODE A CODE=  7777
      **** TEST RUNNING ****
```

```
** MODE S UF21 TEST - FAILED **

DF21 FS=0  DR=00 UM=00 ID=7377
MB=00000000000000     →ADDRESS=3BD422
DF11 ADDR=3AC421
        Press RUN to start
```

```
** MODE S UF21 TEST - FAILED **

→DF16 FS=0  DR=00 UM=00 ID=3247
 MB=00000000000000      ADDRESS=3AC421

        Press RUN to start
```

```
** MODE S UF21 TEST - NO REPLY **

DF    FS=    DR=    UM=    ID=
MB=                        ADDRESS=

        Press RUN to start
```

Sample Mode S UF21 Test Screens
Figure 24

16. Squitter (Refer to 1-2-4, Figure 25.)

Verifies time Period between UUT squitters is 0.8 to 2.4 seconds. Measured time between UUT squitters is displayed along with squitter address (hexadecimal and octal) and tail number.

```
    ** SQUITTER TEST - PASSED **
PERIOD = 1.00 SECONDS
TAIL NUMBER = N12345
SQUITTER ADDRESS=3AC421 [16542041]

         Press RUN to start
```

```
    ** SQUITTER TEST - FAILED **
→PERIOD = 2.64 SECONDS
 TAIL NUMBER = N12345
 SQUITTER ADDRESS=3AC421 [16542041]

         Press RUN to start
```

Sample Squitter Test Screens
Figure 25

17. Frequency (Refer to 1-2-4, Figure 26.)

Verifies UUT frequency is 1090 MHz (±3 MHz). UUT frequency is displayed.

```
** FREQUENCY TEST - PASSED **

     FREQUENCY = 1092.30 MHz

       Press RUN to start
```

```
** FREQUENCY TEST - FAILED **

     →FREQUENCY = 1086.80 MHz

       Press RUN to start
```

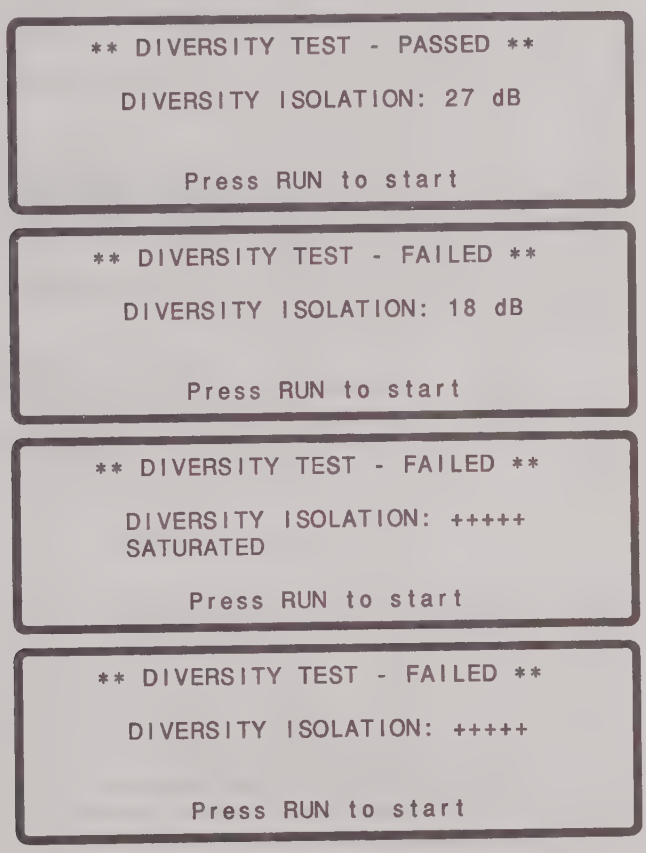
Sample Frequency Test Screens
Figure 26

TEST DESCRIPTION

18. Diversity (Refer to 1-2-4, Figure 27.)

Verifies UUT diversity isolation is ≥20 dB. Diversity isolation is displayed.

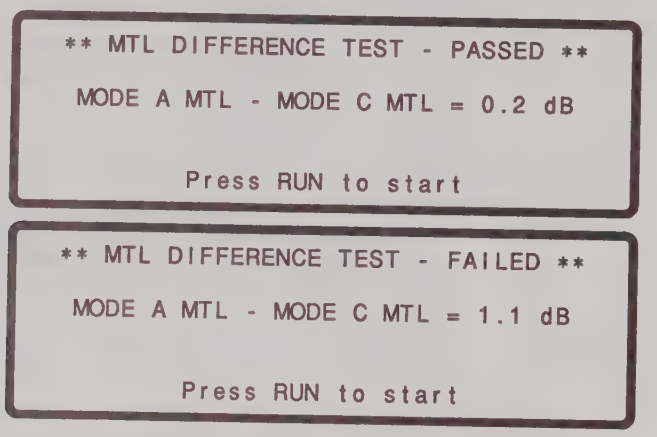
NOTE: To insure ≥20 dB dynamic range, test must be run within 50 feet (15.24 meters) of UUT Antenna being tested.


** DIVERSITY TEST - PASSED **
DIVERSITY ISOLATION: 27 dB
Press RUN to start
** DIVERSITY TEST - FAILED **
DIVERSITY ISOLATION: 18 dB
Press RUN to start
** DIVERSITY TEST - FAILED **
DIVERSITY ISOLATION: +++++
SATURATED
Press RUN to start
** DIVERSITY TEST - FAILED **
DIVERSITY ISOLATION: +++++
Press RUN to start

Sample Diversity Test Screens
Figure 27

19. MTL Difference (Refer to 1-2-4, Figure 28.)

Verifies Receiver Sensitivity or MTL to Mode A interrogations does not differ more than 1 dB from MTL to Mode C interrogations. The MTL difference, based on the average of 100 Mode A and 100 Mode C interrogations, is displayed.


** MTL DIFFERENCE TEST - PASSED **
MODE A MTL - MODE C MTL = 0.2 dB
Press RUN to start
** MTL DIFFERENCE TEST - FAILED **
MODE A MTL - MODE C MTL = 1.1 dB
Press RUN to start

Sample MTL Difference Test Screens
Figure 28

E. Power Test

(1) General

The function of the Power Test is to accurately determine the ERP and MTL of the transponder, whether or not a direct connection with UUT is used. Two values for each measurement are provided on the DISPLAY (14). The INSTANTANEOUS values are obtained from the average power readings of the replies received to 100 interrogations. This value is updated every 100 interrogations. The TOP AVG and BOT AVG values are obtained from the average power readings of all replies received during the Power Test sequence.

POWER Test verifies:

- 48.5 dBm <UUT ERP <57.0 dBm
- UUT MTL =-73.0 dBm (±4.0 dBm)

(2) Procedure (Refer to 1-2-4, Figures 29, 30 and 31.)

NOTE: Power Test must be run at the Distance/Range established in Setup Procedure. Refer to 1-2-4, Figures 8, 30 and 31.

STEP	PROCEDURE

1. Press PWR TEST Key (12) to enter Power Test screen. Results from last Power Test are displayed.

2. Select UUT Antenna to be tested, top or bottom, with SELECT Keys (10).

```
              ** POWER TEST **
                        ERP     MTL
·TOP AVG (dBm)  =  53.0   -73.4   PASSED
 BOT AVG (dBm)  =  52.0   -74.3   PASSED
 INSTANTANEOUS  =  52.5   -73.4
              Press RUN to start
```

```
              ** POWER TEST **
                        ERP     MTL
 TOP AVG (dBm)  =  53.0   -73.4   PASSED
·BOT AVG (dBm)  =→47.8   -75.0   FAILED
 INSTANTANEOUS  =  47.8   -75.0
              Press RUN to start
```

USING TEST SET ANTENNA

```
      ** POWER TEST - TOP ANTENNA **

ANTENNA   UNITS    ERP     MTL      STATUS
   TOP      dBm    53.0   -73.4     PASSED

            Press RUN to start
```

```
     ** POWER TEST - BOTTOM ANTENNA **

ANTENNA    UNITS     ERP      MTL     STATUS
 BOTTOM      dBm     53.0    -73.4    PASSED
                       .        .
              Press RUN to start
```

DIRECT CONNECTION

Sample Power Test Screens
Figure 29

STEP PROCEDURE

3. Connect UUT to RF I/O Connector (15) for direct connection or connect a Test Set Antenna (Flat Antenna is most accurate) to ANTENNA Connector (16).

   NOTE: If direct connection is not used, UUT Antenna not being tested must be shielded with Antenna Shield (refer to Appendix D) or disconnected and terminated with 50 Ω load.

   NOTE: If direct connection is used, ATC-601 ANTENNA Connector (16) must be terminated with 50 Ω load (Connector Cover).

4. Press RUN/STOP Key (9) or ANTENNA PUSH BUTTON Switch (21) to initiate Power Test. If Direct Connection is used, go to Step 6.

   NOTE: Test Set displays accurate power readings when Flat Antenna is facing UUT at Setup Range according to 1-2-4, Figures 30 and 31. When more accuracy is required, Step 5 is recommended to reduce errors caused by multipath off the ramp.

5. With Flat Antenna facing UUT Antenna, move slowly (less than 1 ft/sec [30 cm/sec], as follows:

   a. Move Flat Antenna 6 feet (1.8 meters) vertically from the ground. It may be easiest to start from a squatting position with the Flat Antenna a few inches off the ground and raising up to a standing position, moving the Flat Antenna above shoulder level.

   b. Repeat Step 5a as necessary to get most accurate readings.

      NOTE: Do not move toward or away from UUT as this changes Range. Do not rotate Flat Antenna as this reduces power levels.

6. Press RUN/STOP Key (9) or ANTENNA PUSH BUTTON Switch (21) to stop Power Test.

Suggested Layout to Reduce Multipath Errors
Figure 30

Ramp Testing
Figure 31

SECTION 3 - SPECIFICATIONS

1. ATC-601 Transponder Ramp Test Set Specifications

A. Signal Generator

Output Frequency:	1030 MHz (±10 kHz), DCXO controlled
Level:	-57 to -7 dBm typically, into 50 Ω (Automatically controlled to determine receiver sensitivity [MTL] for the selected range and 4 dB typically, higher than MTL for test interrogations)
Test Antenna:	Remote antenna VSWR <1.5:1
Gain:	10 dB typically, specified on the antenna
Range:	6 feet (1.83 meters) to 300 feet (91.44 meters)

B. Test Signals (Interrogations)

Rate:	235 Hz PRF (±5 Hz)

Interlace Ratio (MTL Interrogations to Test Interrogations):

ATCRBS:	2:1
Mode S:	8:1
Modes:	A, C, S, Intermode

NOTE: The ATC-601 interrogates with the mode(s) necessary to run selected test.

C. Pulse Characteristics (measured at 50% amplitude points)

Spacing:

Mode A:

P_1 to P_2:	2.00 µs (±50 ns)
P_1 to P_3:	8.00 µs (±50 ns)

Mode C:

P_1 to P_2:	2.00 µs (±50 ns)
P_1 to P_3:	21.00 µs (±50 ns)

Mode S:	
P_1 to P_2:	2.00 µs (±50 ns)
P_1 to P_6:	3.50 µs (±50 ns)
P_1 to SPR:	4.75 µs (±50 ns)
Intermode:	
Mode A:	
P_1 to P_3:	8.00 µs (±50 ns)
P_1 to P_4:	10.00 µs (±50 ns)
Mode C:	
P_1 to P_3:	21.00 µs (±50 ns)
P_1 to P_4:	23.00 µs (±50 ns)
Widths:	
Mode A:	
P_1, P_2, P_3:	0.80 µs (±50 ns)
Mode C:	
P_1, P_2, P_3:	0.80 µs (±50 ns)
Mode S:	
P_1, P_2:	0.80 µs (±50 ns)
P_6 (Short):	16.25 µs (±50 ns)
P_6 (Long):	30.25 µs (±50 ns)
Intermode:	
P_1, P_2, P_3:	0.80 µs (±50 ns)
P_4 (Short):	0.80 µs (±50 ns)
P_4 (Long):	1.60 µs (±50 ns)

Rise and Fall Times:

Rise time (all modes):	50 to 100 ns
Fall time (all modes):	50 to 200 ns

Phase Modulation:

Transition time:	≤80 ns
Phase shift:	180° (±10°)

Amplitude Levels:

SLS Level (P_2):	-9 dB (±1 dB) and 0 dB relative to P_1 level

NOTE: SLS Level is automatically controlled in the SLS LEVEL Test.

D. UUT Measurements (Replies)

XMTR Frequency:

Range:	1087 to 1093 MHz
Accuracy:	±50 kHz
Resolution:	10 kHz

XMTR Power (at 1090 MHz):

Direct Connection-Peak Pulse Power:

Range:	+46.5 to +59 dBm (45 to 800 W)
Accuracy:	±1 dB
Resolution:	0.1 dB

Effective Radiated Power (ERP):

Range:	+48.5 to +57 dBm (71 to 500 W)

Receiver Sensitivity:

Direct Connection - Minimum Triggering Level (MTL):

Range:	-67 to -79 dBm
Accuracy:	±2 dB

Radiated Field Strength (MTL):

Range:	-69 to -77 dBm into 0 dBi antenna (-77 dB W/m^2 to -85 dB W/m^2)

Reply Delay:

ATCRBS:

Range:	1.80 to 7.00 µs
Accuracy:	±100 ns

Mode S and ATCRBS/Mode S All-Call:

Range:	125.00 to 131.00 µs
Accuracy:	±100 ns

Reply Jitter:

ATCRBS:

Range:	0.00 to 2.30 µs
Accuracy:	±50 ns

Mode S and ATCRBS/Mode S All-Call:

Range:	0.00 to 6.00
Accuracy:	±50 ns

F_1 to F_2 Spacing:

Range:	19.70 to 21.60 µs
Accuracy:	±50 ns

F_1 and F_2 Pulse Width:

Range:	0.25 to 1.00 µs
Accuracy:	±50 ns

Squitter Period:

Range:	0.10 to 4.88 seconds
Accuracy:	±10 ms

Diversity Isolation:

Range:	0 to >20 dB (depending on Antenna Range)
Antenna Range:	6 feet (1.83 meters) to 50 feet (15.24 meters)
Accuracy:	±3 dB

SLS Test (at MTL + 10 dB):

Antenna Range:	6 feet (1.83 meters) to 95 feet (28.96 meters)

E. Power

Battery operation:

Duration:	≥2 hours before recharge at 25° C
Automatic shutoff:	after 15 minutes of non-use

ac Input:	103.5 to 129/207 to 258 VAC, 47.5 to 420 Hz, 30 W (used to recharge battery)

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SECTION 4 - SHIPPING

1. General

The following information applies to shipping and repacking procedures for the Test Set.

A. Shipping Information

IFR Test Sets returned to factory for calibration, service or repair must be repackaged and shipped subject to the following conditions:

(1) Authorization

Do not return any products to factory without first receiving authorization from IFR Customer Service Department.

CONTACT: IFR Systems, Inc.
Customer Service Dept.
10200 West York Street
Wichita, Kansas 67215

Telephone: 800-835-2350
TWX: 910-741-6952

(2) Tagging Test Sets

All test sets must be tagged with:

- Owner's identification and address.
- Nature of service or repair required.
- Model No.
- Serial No.

(3) Shipping Containers

Test Sets must be repackaged in original shipping containers using IFR packing models. If original shipping containers and materials are not available, contact IFR Customer Service Dept. for shipping instructions.

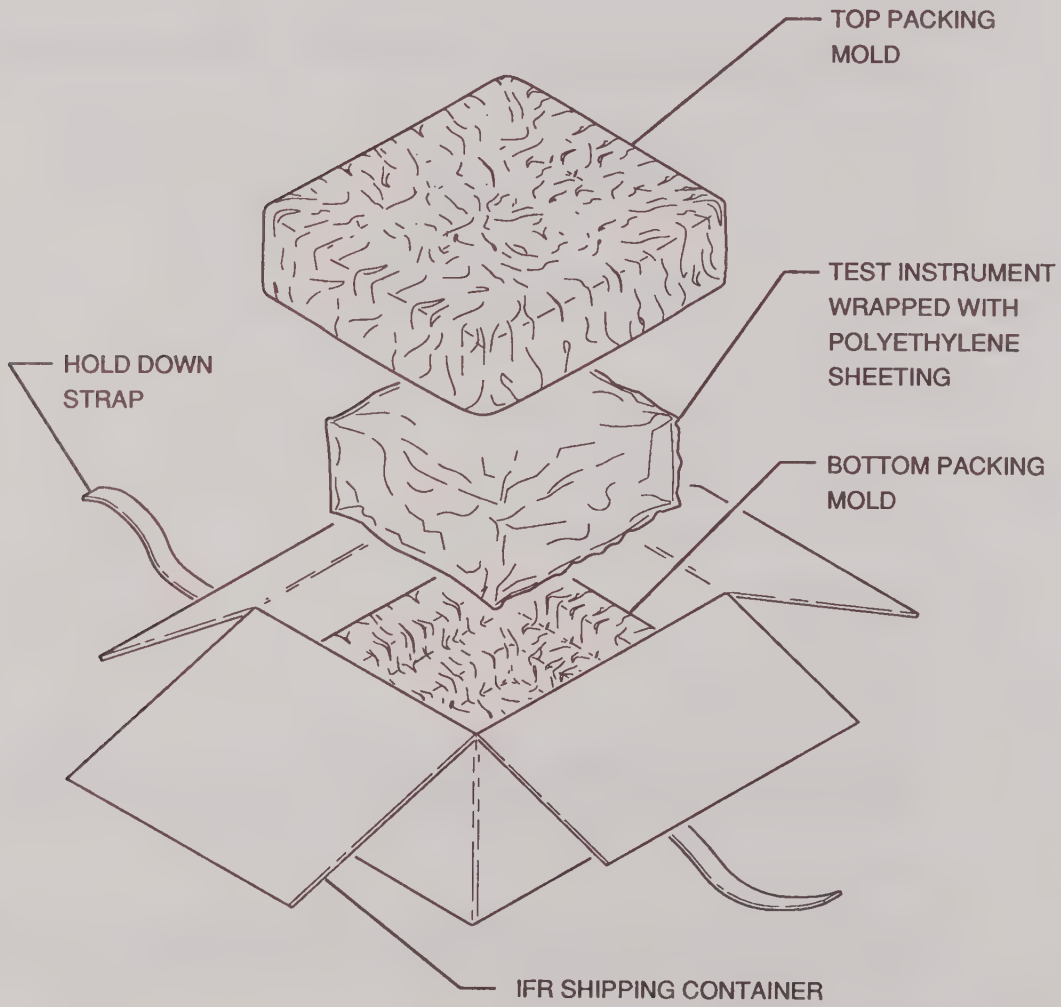
(4) Freight Costs

All freight costs on non-warranty shipments are assumed by customer. (See "Warranty Packet" for freight charge policy on warranty claims.)

B. Repacking Procedure (1-4-1, Figure 1)

- Make sure bottom packing mold is seated on floor of shipping container.
- Carefully wrap Test Set with polyethylene sheeting to protect finish.

- Place test set into shipping container, making sure Test Set is securely seated in bottom packing mold.
- Place top packing mold over top of set and press down until mold rests solidly in bottom packing mold.
- Close shipping container lids and seal with shipping tape or an industrial stapler. Tie all sides of container with break resistant rope, twine or equivalent.



Repacking Procedure
Figure 1

SECTION 5 - STORAGE

1. General

The following storage precautions should be accomplished whenever the Test Set is stored for extended periods:

- Disconnect the Test Set from any electrical power source.
- Disconnect and store the ac power cable and other accessories with the Test Set.
- Cover the Test Set to prevent dust and debris from covering and entering the Test Set.

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APPENDIX A - I/O CONNECTORS AND PIN-OUT TABLES

1. Table of I/O Connectors

CONNECTOR	SIGNAL NAME	TYPE	INPUT/OUTPUT	SIGNAL TYPE
J10050	AC PWR	AMPHENOL	INPUT	ac LINE POWER
J10053	COMM	LEMO	INPUT/OUTPUT	RS-232C
	(Refer to Appendix A, COMM Connector Pin-out Table)			
J10054	REPLY VIDEO	BNC	OUTPUT	VIDEO (Direct Connection Only)
J10055	SYNC	BNC	OUTPUT	TTL
J10056	MONITOR	BNC	OUTPUT	TTL VIDEO
J10057	ANTENNA	BNC	INPUT/OUTPUT	RF
J10058	RF I/O	TNC	INPUT/OUTPUT	RF

2. COMM Connector (J10053) Pin-out Table

PIN NO.	SIGNAL NAME	SIGNAL TYPE	INPUT/OUTPUT	POLARITY
1	EXT SYNC	TTL	INPUT	RISING EDGE
2	EXT PULSE	TTL	INPUT	ACTIVE LOW
3	EXT DPSK IN	TTL	INPUT	
4	EXT DPSK OUT	CMOS	OUTPUT	
5	SPARE			
6	TXD	BIPOLAR	OUTPUT	
7	DTR	BIPOLAR	OUTPUT	ACTIVE LOW
8	RXD	BIPOLAR	INPUT	
9	CTS	BIPOLAR	INPUT	ACTIVE LOW
10	GND		OUTPUT	GROUND

APPENDIX B - ABBREVIATIONS

A

AA	Announced Address
AC	Altitude Code
AC/ac	Alternating Current
ACAS	Airborne Collision Avoidance System
ACS	Comm-A Capability Subfield
A/D	Analog to Digital
ADC	Analog to Digital Convertor
AIS	Comm-A Capability Subfield
ALT	Altitude
AP	Address Parity
AQ	Special Acquisition
ATC	Air Traffic Control
ATC	ATCRBS (screen abbreviation)
ATCRBS	Air Traffic Control Radar Beacon System
ATE	Automatic Test Equipment
ATTEN	Attenuation
AUTO	Automatic
AVG	Average

B

BCS	Comm-B Capability Subfield
BDS	B-Definition Subfield
BIT	Built In Test
BOT	Bottom
BR	Bridge Rectifier
BT	Battery

C

C	Centigrade
CA	Transponder Capability
CAS	Column Address Strobe
CFS	Continuation Subfield
CH	Channel
CHC	Cancel Horizontal Resolution Advisory Complement
CLI	Coordination Lock Indicator
CMOS	Complementary Metal-Oxide Semiconductor
COMM	Communication
Cont	Continued
CR	Diode
CTS	Clear to Send
CVC	Cancel Vertical Resolution Advisory Complement
CW	Continuous Wave

D

D/A	Digital to Analog
DAC	Digital to Analog Convertor
dB	Decibel
dBi	Decibels above isotropic
dBm	Decibels above one milliwatt
dB W/m^2	Decibels above one watt per square meter
DCXO	Digitally Compensated Crystal Oscillator
DF	Downlink Format
DI	Designator Identification
Div	Division
DMA	Direct Memory Access
DMM	Digital Multimeter
DPR	Dual Port RAM
DPSK	Differential Phase Shift Key
DR	Downlink Request
DSP	Digital Signal Processor
DTR	Data Terminal Ready

E

ECS	Extended Capability Subfield
ELM	Extended Length Message
ERP	Effective Radiated Power
ESB	Encoded Sense Bits
Ext	External

F

FCC	Federal Communications Commission
FET	Field Effect Transistor
FIFO	First In First Out
FPM	Feet Per Minute
FREQ	Frequency
FS	Flight Status
Ft	Feet

G

GEN	Generator
GND	Ground
GPIB	General Purpose Interface Bus

H

h	Hexidecimal
HET	Heterodyne
hr	Hour
HRC	Horizontal Resolution Advisory Complement
Hz	Hertz

I

ID	Identification (4906 Code)
IDS	Identifier Designators Subfield
IF	Intermediate Frequency
IFR	IFR Systems, Inc
II	Interrogator Identification
IIS	Interrogator Identification Subfield
INTERR	Interrogation
I/O	Input/Output
ITM	Intermode

K

KE	ELM Control
kHz	Kilohertz (10^3)
km	Kilometer (10^3)
kts	Knots (Velocity)

L

LC	Inductor-Capacitor
LCA	Logic Cell Array
LCD	Liquid Crystal Display
LCK	Coordination Lock Subfield
LCS	Lower Chip Select
LED	Light Emitting Device
LO	Local Oscillation
LOS	Lockout Subfield
LSD	Least Significant Digit

M

m	meters
MA	Comm-A Message
Max	Maximum
MB	Comm-B Message
MBS	Multisite Comm-B Subfield
MC	Comm-C Message
MCS	Mid-Range Chip Select
MD	Comm-D Message
MEAS	Measuring
MES	Multisite ELM Subfield
MHz	Megahertz (10^6)
µs	Microsecond
MID	Mode S Address
MPU	Microprocessing Unit
ms	Millisecond (10^{-3})
MSD	Most Significant Digit
MTB	Multiple Threat Bit
MTL	Minimum Triggering Level
MU	Comm-U Message
MV	Comm-V Message

N

N/A	Not Applicable
NC	C-Segment Number
ND	D-Segment Number
nmi	Nautical Miles
No	Number
ns	Nanosecond (10^{-9})

O

O'SCOPE	Oscilloscope

P

PC	Protocol
PC	Printed Circuit
PCBD	Printed Circuit Board
PCS	Peripheral Chip Select
PI	Parity/Interrogator Identity
PPG	Pulse Power Gate
PPM	Pulse Position Modulation
PR	Reply Probability
PRF	Pulse Repetition Frequency
PWM	Pulse Width Modulation
PWR	Power

R

RAM	Random Access Memory
RAC	Resolution Advisory Complement
RAS	Row Address Strobe
RC	Reply Control
RC	Resistor-Capacitor
RCVR	Receiver
Ref	Reference
RF	Radio Frequency
RI	Reply Information, Air-to-Air
RL	Reply Length
RMS	Root Mean Square
ROM	Read Only Memory
RR	Reply Request
RRS	Reply Request Subfield
RSS	Reservation Status Subfield
RTCA	Radio Technical Commission for Aeronautics

S

SD	Special Designator
sec	Second(s)
SL	Sensitivity Level
SLS	Side Lobe Suppression
SMENU	Sequence Menu
SPI	Special Identifier Pulse
SPR	Synchronous Phase Reversal
SRQ	Service Request
SRS	Segment Request Subfield
SSR	Secondary Surveillance Radar
SYNC	Synchronization

T

T	Transformer
TAS	Transmission Acknowledgement Subfield
TCAS	Traffic Alert and Collision Avoidance System
TMS	Tactical Message Subfield
Trig	Trigger
TTL	Transistor Transistor Logic

U

UART	Universal Asynchronous Receiver-Transmitter
UCS	Upper Chip Select
UDS	U-Definition Subfield
UF	Uplink Format
UM	Utility Message
UUT	Unit Under Test

V

V	Volts
VAC	Volts Alternating Current
VCO	Voltage Controlled Oscillator
Vdc	Volts Direct Current
VDS	V-Definition Subfield
VERS	Version
VRAM	Video Random Access Memory
VRC	Vertical Resolution Advisory Complement
Vrms	Volts Root Mean Square
VS	Vertical Status
VSWR	Voltage Standing Wave Ratio

W

W	Watts

X

XMTR	Transmitter
XOR	Exclusive OR
XPDR	Transponder

APPENDIX C - SIGNAL FORMATS

1. Operating Goals

Mode S is a combined secondary surveillance radar and a potential ground-air-ground data link system capable of providing aircraft surveillance and communications necessary to support automated ATC in dense traffic environments. Mode S is capable of common-channel interoperation with the ATC beacon system and may be implemented over an extended ATCRBS-to-Mode S transition period. In supporting ATC automation, Mode S is capable of providing the reliable communications necessary for data link services.

2. Mode S Message Content

A. Address/Parity (Field AP)

All discrete Mode S interrogations (56-bit or 112-bit) and replies (except the All-Call reply) contain the 24-bit discrete address of the Mode S transponder upon which 24 error-detecting parity check bits are overlaid. In the All-Call reply, the 24 parity check bits are overlaid on the address of the Mode S interrogator and the discrete address of the transponder is included in the text of the reply.

B. Surveillance

The primary function of Mode S is surveillance. For the Mode S transponder, this function is accomplished with the use of "short" (56-bit) transmissions in both directions. In these transmissions, the aircraft reports altitude (DF04) or ATCRBS 4096 code as well as flight status (airborne, on the ground, alert, Special Position Identification [SPI], etc.).

C. Data Link Communications

The discrete addressing and digital encoding allow Mode S transmissions to be used as digital data links. The interrogation and reply formats of the Mode S system contain sufficient coding space to transmit data. Most Mode S data link transmissions are handled as one 56-bit message included as part of "long" 112-bit interrogations or replies. The transmissions include the message in addition to surveillance data, and is generally used in place of a surveillance interrogation and/or reply.

An efficient transmission of longer messages is accomplished by the extended length message (ELM) capability (UF24 and DF24). Using this capability, a sequence of up to sixteen 80-bit message segments (each with a 112-bit transmission) is transmitted, either ground-to-air or air-to-ground and is acknowledged with a single reply/interrogation. ELMs do not contain surveillance data and thus cannot substitute for a surveillance interrogation-reply cycle.

3. Signal Formats

Signal formats for both Uplink and Downlink messages are outlined in Chapter 2, RTCA DO-181 and Chapter 2, Volume I of RTCA DO-185. Tables 1, 2, 3 and 4 contain explanations of signals and their meanings.

NOTE: TCAS operates in Mode S and many signals pertain only to TCAS.

FORMAT NO.	UF	
0	(0 0000)	--3--(RL:1)—4—(AQ:1)——18——(AP:24) ..... Short Air-Air Surveillance
1	(0 0001)	————————27 or 83————————(AP:24)
2	(0 0010)	————————27 or 83————————(AP:24)
3	(0 0011)	————————27 or 83————————(AP:24)
4	(0 0100)	(PC:3) (RR:5) (DI:3) (SD:16) (AP:24) ... Surveillance, Altitude Request
5	(0 0101)	(PC:3) (RR:5) (DI:3) (SD:16) (AP-24) ....Surveillance, Identity Request
6	(0 0110)	————————27 or 83————————(AP:24)
7	(0 0111)	————————27 or 83————————(AP:24)
8	(0 1000)	————————27 or 83————————(AP:24)
9	(0 1001)	————————27 or 83————————(AP:24)
10	(0 1010)	————————27 or 83————————(AP:24)
11	(0 1011)	(PR:4) (II:4)————-19————-(AP:24) ..... Mode S Only All-Call
12	(0 1100)	————————27 or 83————————(AP:24)
13	(0 1101)	————————27 or 83————————(AP:24)
14	(0 1110)	————————27 or 83————————(AP:24)
15	(0 1111)	————————27 or 83————————(AP:24)
16	(1 0000)	-3-(RL:1)-4-(AQ:1)—18—(MU:56) (AP:24) ..... Long Air-Air Surveillance
17	(1 0001)	————————27 or 83————————(AP:24)
18	(1 0010)	————————27 or 83————————(AP:24)
19	(1 0011)	————————27 or 83————————(AP:24)
20	(1 0100)	(PC:3) (RR:5) (DI:3) (SD:16) (MA:56) (AP:24) ..Comm-A, Altitude Request
21	(1 0101)	(PC:3) (RR:5) (DI:3) (SD:16) (MA:56) (AP:24) ..Comm-A, Identity Request
22	(1 0110)	————————27 or 83————————(AP:24)
23	(1 0111)	————————27 or 83————————(AP:24)
24	(1 1xxx)	(RC:2) (NC:4) (MC:80) (AP:24) ..... Comm-C (ELM)

NOTES: (1) (XX:M) denotes a field designated "XX" which is assigned M bits.
(2) —N— denotes free coding space with N available bits. These are coded as ZEROs for transmission.
(3) For Uplink Formats (UF) 0 through 23, the format number corresponds to the binary code in the first 5 bits of the interrogation. Format number 24 is arbitrarily defined as the format beginning with "11" in the first two bit positions while the following three bits (xxx) vary with the interrogation content.
(4) All formats are shown for completeness, although a number of them are unused.

Overview of Mode S Interrogation Formats
Table 1

FORMAT NO. DF	
0	(0 0000) (VS:1)-2-(SL:3)-2-(RI:4)-2-(AC:13) (AP:24) ..... Short Air-Air Surveillance
1	(0 0001) -————————27 or 83————————-(P:24)
2	(0 0010) -————————27 or 83————————-(P:24)
3	(0 0011) -————————27 or 83————————-(P:24)
4	(0 0100) (FS:3) (DR:5) (UM:6) (AC:13) (AP:24) ...Surveillance, Altitude Request
5	(0 0101) (FS:3) (DR:5) (UM:6) (ID:13) (AP-24) ...Surveillance, Identity Request
6	(0 0110) -————————27 or 83————————-(P:24)
7	(0 0111) -————————27 or 83————————-(P:24)
8	(0 1000) -————————27 or 83————————-(P:24)
9	(0 1001) -————————27 or 83————————-(P:24)
10	(0 1010) -————————27 or 83————————-(P:24)
11	(0 1011) (CA:3) (AA:24) (PI:24) ..... All-Call Reply
12	(0 1100) -————————27 or 83————————-(P:24)
13	(0 1101) -————————27 or 83————————-(P:24)
14	(0 1110) ————————27 or 83————————-(P:24)
15	(0 1111) -————————27 or 83————————-(P:24)
16	(1 0000)(VS:1)-2-(SL:3)-2-(RI:4)-2-(AC:13)(MV:56)(AP:24) .Long Air-Air Surveillance
17	(1 0001) -————————27 or 83————————-(P:24)
18	(1 0010) -————————27 or 83————————-(P:24)
19	(1 0011) -————————27 or 83————————-(P:24)
20	(1 0100) (FS:3) (DR:5) (UM:6) (AC:13) (MB:56) (AP:24) . Comm-B, Altitude Request
21	(1 0101) (FS:3) (DR:5) (UM:6) (ID:13) (MB:56) (AP:24) ...Comm-B, Identity Request
22	(1 0110) -————————27 or 83————————-(P:24)
23	(1 0111) -————————27 or 83————————-(P:24)
24	(1 1xxx) (KE:1) (ND:4) (MD:80) (AP:24) .....Comm-D (ELM)

NOTES: (1) (XX:M) denotes a field designated "XX" which is assigned M bits. (P:24) denotes a 24-bit field reserved for parity information.
(2) —N— denotes free coding space with N available bits. These are coded as ZEROs for transmission.
(3) For Downlink Formats (DF) 0 through 23, the format number corresponds to the binary code in the first 5 bits of the reply. Format number 24 is arbitrarily defined as the format beginning with "11" in the first two bit positions while the following three bits (xxx) vary with reply content.
(4) All formats are shown for completeness, although a number of them are unused.

Overview Of Mode S Reply Formats
Table 2

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
AA		24	9-32		X	The aircraft address in the clear, used in DF=11, the All-Call reply.
AC		13	20-32		X	The altitude code used in formats DF=0, 4, 16, and 20. All bits are "0" if altitude information is not available. Contains metric altitude if M-bit (26) is "1".
AP		24 24	33-56 89-112	X	X	Parity over!aid on the address appears at the end of all transmissions, both uplink and downlink, with the exception of format DF=11.
AQ		1	14	X		Designates formats UF=0, 16 as acquisition transmissions. Bit 14 (RI, DF=0, 16) repeats AQ as received by transponder.
CA		3	6-8		X	Reports transponder capability and is used in DF=11, the All-Call reply. The codes are: 0 = No communications capability (surveillance only,) Transponder accepts UF=0, 4, 5, 11; Transponder transmits DF=0, 4, 5, 11. 1 = Comm-A and Comm-B capability, Transponder accepts UF=0, 4, 5, 11, 20, 21; Transponder transmits DF=0, 4, 5, 11, 20, 21. 2 = Comm-A, Comm-B and uplink ELM capability, Transponder accepts UF=0, 4, 5, 11, 20, 21, 24; Transponder transmits DF=0, 4, 5, 11, 20, 21. 3 = Comm-A, Comm-B, uplink and downlink ELM capability, Transponder accepts UF=0, 4, 5, 11, 20, 21, 24; Transponder transmits DF=0, 4, 5, 11, 20, 21, 24. 4-7 = Not assigned. **NOTE:** If CA code is "1", "2" or "3"; the data link capability report is used to indicate the specific data link capabilities of the overall airborne installation.
DF		5	1-5		X	The first field in all downlink formats is the transmission descriptor.

Overview of Format Definitions
Table 3

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
DI		3	14-16	X		Identifies coding contained in the SD field in formats UF=4, 5, 20, 21. The codes are: 0 = SD has Interrogator Identifier (IIS). 1 = SD contains (IIS, MBS, MES, LOS, RSS, TMS). 2-6 = Not assigned. 7 = SD contains (IIS, RRS, LOS, TMS).
DR		5	9-13		X	Requests extraction of downlink messages from the transponder by the interrogator and appears in formats DF=4, 5, 20, 21. The codes are: 0 = No downlink request. 1 = Request to send Comm-B message (B bit set) 2 = TCAS information available. 3 = TCAS information available and request to send Comm-B message. 4 = Comm-B Broadcast #1 available. 5 = Comm-B Broadcast #2 available. 6 = TCAS information and Comm-B Broadcast #1 available. 7 = TCAS information and Comm-B Broadcast #2 available. 8-15 = Not assigned. 16-31 = Request to send n-segments, signified by 15 + n. Codes 1-15 take precedence over codes 16-31.
FS		3	6-8		X	Reports the flight status of the aircraft and is used in formats DF=4, 5, 20, 21. The codes are: Code / Alert / SPI / Airborne / On the Ground 0 / no / no / yes / no 1 / no / no / no / yes 2 / yes / no / yes / no 3 / yes / no / no / yes 4 / yes / yes / either 5 / no / yes / either 6, 7 are not assigned.
ID		13	2-32		X	The 4096 identification code, numbers as set by the pilot, in DF=5, 21.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
II		4	10-13	X		Identifies the interrogator and appears in UF=11, the Mode S-Only All-Call. **NOTE:** The same information may also appear in the IIS subfields.
KE		1	4		X	Defines the content of the ND and MD fields in Comm-D replies, DF=24.
MA		56	33-88	X		Messages directed to the aircraft, part of Comm-A interrogations, UF=20, 21.
	SLC	4	41-44	X		Sensitivity Level Command for the TCAS aircraft. The codes are: 0 = No command 1 = Set TCAS Sensitivity Level to 1. 2 = Set TCAS Sensitivity Level to 2. 3 = Set TCAS Sensitivity Level to 3. 4 = Set TCAS Sensitivity Level to 4. 5 = Set TCAS Sensitivity Level to 5. 6 = Set TCAS Sensitivity Level to 6. 7 = Set TCAS Sensitivity Level to 7. 8-14 = Not Assigned 15=Cancel previous Sensitivity Level command from this site.
MB		56	33-88		X	Messages to be transmitted to the interrogator, part of the Comm-B replies, DF=20, 21. The field contains Data Link Capability Reports or Aircraft Identification Reports or TCAS Resolution Advisory Reports.
	ACS	20	45-64		X	Comm-A capability subfield reports data link service(s) supported by the installation. If all bits are "0", no Comm-A data link services are supported.
	AIS	48	41-88		X	Aircraft Identification Number, reported when a surveillance or Comm-A interrogation (UF=4, 5, 20, 21) contains RR=18 and DI=anything but 7. AIS contains up to eight 6-bit characters as defined in Table 4.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
MB	ARA	14	41-54		X	TCAS Resolution Advisory Report indicating current Active Resolution Advisories (if any) generated by own TCAS unit against one or more threat aircraft. Each bit indicates a specific resolution advisory with "1" being active and "0" being inactive. Bit indications are: 41-Climb. 42-Don't descend. 43-Don't descend faster than 500 FPM. 44-Don't descend faster than 1000 FPM. 45-Don't descend faster than 2000 FPM. 46-Descend. 47-Don't climb. 48-Don't climb faster than 500 FPM. 49-Don't climb faster than 1000 FPM. 50-Don't climb faster than 2000 FPM. 51-Turn left. 52-Turn right. 53-Don't turn left. 54-Don't turn right.
	BCS	16	65-80		X	Comm-B capability subfield reports installed data sources that can be accessed by the ground for transmission via a ground-initiated Comm-B. If all bits are "0", no data is accessible by a ground-initiated Comm-B.
	BDS	8	33-40		X	Defines the content of the MB message field in reply to ground-initiated Comm-B and is expressed in two groups of 4 bits each, BDS1 (33-36) and BDS2 (37-40).
	BDS1	4	33-36		X	Corresponds with RR in UF=4, 5, 20 and 21. The codes are: 0 = MB contains Air-initiated Comm-B. 1 = MB contains Data Link Capability Report. 2 = MB contains Aircraft Identification. 3 = MB contains TCAS Resolution Advisory. 4-15 = Not assigned.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
MB	BDS2	4	37-40		X	Basic report uses BDS2=0. More complex Mode S installations report additional capabilities in various formats assigned to BDS2 codes other than "0" as requested by interrogator, specified in the RRS subfield of SD.
	CFS	4	41-44		X	Continuation subfield contains the BDS2 value of the next additional capability report available from the installation.
	CLI	1	59		X	Coordination Lock Indicator, used in TCAS Resolution Advisories, indicating current coordination lock state of own TCAS aircraft. The codes are: 0 = Own TCAS aircraft is not currently in a coordination lock state or is in a lock state with the TCAS aircraft, the Resolution Advisory is addressed to. 1 = Own TCAS aircraft is currently in a coordination lock state with a TCAS aircraft other than the one the Resolution Advisory is addressed to or is locked due to own housekeeping logic.
	ECS	8	81-88		X	Data Link Capability subfield reports the ELM capability of the installation. If all bits are "0", no ELM data link services are supported.
	RAC	4	55-58		X	Resolution Advisory Complements subfield indicates currently active resolution advisory complements (if any) received from all other TCAS aircraft with on-board resolution capability. Bits are set to "1" when active and "0" when inactive. Bit indications are: 55-Don't descend. 56-Don't climb. 57-Don't turn right. 58-Don't turn left.
MC		80	9-88	X		Comm-C field contains one segment of a sequence of segments transmitted to the transponder in the ELM mode. MC is part of UF=24.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
MC	SRS	16	9-24	X		If a Comm-C interrogation (UF=24) contains RC=3, the SRS subfield contains a list of segment request-authorizations in the 16-bit (9-24) SRS subfield. Starting with bit 9, denoting the first segment, each of the following bits is set to "1" if the transmission of the corresponding segment is requested.
MD		80	9-88		X	Comm-D field, part of DF=24, contains one segment of a sequence of segments transmitted by the transponder in the ELM mode. It may contain a summary of received MC segments of an uplink ELM.
	TAS	16	17-32		X	Reports the segments received so far in a Comm-C sequence. Starting with bit 17, denoting number "0", each of the following bits is "1" if the corresponding segment of the sequence has been received. TAS appears in MD if KE=1 in the same reply.
MU		56	33-88	X		Field, part of the long air-air surveillance interrogation UF=16, contains information used in air-to-air exchanges (TCAS Resolution Advisories Lock Request, TCAS Resolution Message and TCAS Broadcast Message).
	CHC	2	47-48	X		Cancel Horizontal Resolution Advisory Complement. In TCAS Resolution Advisories Request Messages and TCAS Resolution Messages transmitted by TCAS without horizontal resolution capability, CHC is set to "0". The codes are: 0 = No cancellation. 1 = Cancel, don't turn left. 2 = Cancel, don't turn right. 3 = Not assigned.
	CVC	2	43-44	X		Cancel Vertical Resolution Advisory Complement. The codes are: 0 = No cancellation. 1 = Cancel, don't descend. 2 = Cancel, don't climb. 3 = Not assigned.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
MU	ESB	4	61-64	X	Encoded Sense Bits, a parity coding field used to protect the four vertical sense bits (CVC and VRC), is sent in all TCAS Resolution Messages. If bits 43-46 do not agree with bits 61-64, as shown, the TCAS receiver assumes there is an error and disregards message. Bits are set as follows:

43	44	45	46	61	62	63	64
0	0	0	0	0	0	0	0
0	0	0	1	1	1	1	0
0	0	1	0	0	1	1	1
0	0	1	1	1	0	0	1
0	1	0	0	1	0	1	1
0	1	0	1	0	1	0	1
0	1	1	0	1	1	0	0
0	1	1	1	0	0	1	0
1	0	0	0	1	1	0	1
1	0	0	1	0	0	1	1
1	0	1	0	1	0	1	0
1	0	1	1	0	1	0	0
1	1	0	0	0	1	1	0
1	1	0	1	1	0	0	0
1	1	1	0	0	0	0	1
1	1	1	1	1	1	1	1

	HRC	2	49-50	X	Horizontal Resolution Advisory Complement. In TCAS Resolution Advisories Request Messages and TCAS Resolution Messages transmitted by TCAS without horizontal resolution capability, HRC is set to "0". The codes are: 0 = No horizontal resolution advisory complement sent. 1 = Don't turn left. 2 = Don't turn right. 3 = Not assigned.
	LCK	1	41	X	Coordination Lock subfield. The codes are: 0 = Exit coordination lock state (TCAS Resolution Message). 1 = Enter coordination lock state (TCAS Resolution Advisories Lock Request).

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
MU	MID	24	65-88	X		Contains the discrete address of the interrogating aircraft and is included in TCAS Resolution Advisories Lock Request, TCAS Resolution Message and TCAS Broadcast Message. **NOTE:** TCAS Broadcast Message is sent at 10-second intervals.
	MTB	1	42	X		Multiple Threat Bit indicates more than one TCAS threat when set to "1" and no more than one threat when set to "0".
	UDS	8	33-40	X		Defines the content of the MU message field and is expressed in two 4-bit groups, UDS1 (33-36) and UDS2 (37-40).
	UDS1	4	33-36	X		Is set to "3" for TCAS Resolution Advisories Lock Request, TCAS Resolution Message or TCAS Broadcast Message.
	UDS2	4	37-40	X		Is set to "0" for TCAS Resolution Advisories Lock Request or TCAS Resolution Message and set to "2" for TCAS Broadcast Message.
	VRC	2	45-46	X		Vertical Resolution Advisory Complement. The codes are: 0 = No vertical resolution advisory complement sent. 1 = Don't descend. 2 = Don't climb. 3 = Not assigned.
MV		56	33-88		X	Field, part of the long air-air surveillance reply DF=16, contains information used in air-to-air exchanges (Coordination Reply Message).
	ARA	14	41-54		X	Same as in MB field.
	CLI	1	59		X	Same as in MB field.
	RAC	4	55-58		X	Same as in MB field.
	VDS	8	33-40		X	Defines the content of the MV message field and is expressed in two 4-bit groups, VDS1 (33-36) and VDS2 (37-40).

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
■	VDS1	4	33-36		X	Is set to "3" for Coordination Reply Message.
■	VDS2	4	37-40		X	Is set to "0" for Coordination Reply Message.
NC		4	5-8	X		Provides the number of the segment transmitted in an uplink ELM and is part of a Comm-C interrogation, UF=24.
ND		4	5-8		X	Provides the number of the segment transmitted in an downlink ELM and is part of a Comm-D reply, DF=24.
PC		3	6-8	X		Contains operating commands to the transponder and is part of surveillance and Comm-A interrogations UF=4, 5, 20, 21. The codes are: 0 = No changes in transponder state. 1 = Non-selective All-Call lockout. 2 = Not assigned. 3 = Not assigned. 4 = Cancel B 5 = Cancel C 6 = Cancel D 7 = Not assigned.
PI		24	33-56		X	Contains the parity overlaid on the interrogator identity code. PI is part of the reply to Mode S-Only All-Call, DF=11.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
PR		4	6-9	X	Field contains commands to the transponder specifying the reply probability to the Mode S-Only All-Call interrogation, UF=11 that contains the PR. A command to disregard any lockout state can also be given. The assigned codes are: 0 = Reply with probability = 1. 1 = Reply with probability = 1/2. 2 = Reply with probability = 1/4. 3 = Reply with probability = 1/8. 4 = Reply with probability = 1/16. 5, 6, 7 = Do not reply. 8 = Disregard lockout, reply with probability = 1. 9 = Disregard lockout, reply with probability = 1/2. 10=Disregard lockout, reply with probability = 1/4. 11=Disregard lockout, reply with probability = 1/8. 12=Disregard lockout, reply with probability = 1/16. 13, 14, 15 = Do not reply. **NOTE:** On receipt of a Mode S-Only All-Call containing a PR code other than 0 or 8, transponder executes a random process and makes a reply decision for the interrogation in accordance with the commanded probability. Random occurrence of replies enables interrogator to acquire closely spaced aircraft when replies would otherwise synchronously garble each other.
RC		2	3,4	X	Designates the transmitted segment as initial, intermediate or final if coded "0", "1" or "2" respectively. RC=3 is used to request Comm-D downlink action by the transponder. RC is part of the Comm-C interrogation, UF=24.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
RI		4	14-17		X	Air-to-air information in DF=0, 16. The codes are: 0 = No on-board TCAS. 1-2 = Not assigned. 3 = On-board TCAS with vertical-only resolution capability. 4 = On-board TCAS with vertical and horizontal resoulution capability. 5-7 = Not assigned. 8 = No maximum airspeed data available. 9 = Airspeed is ≤75 kts. 10=Airspeed is >75 kts and ≤150 kts. 11=Airspeed is >150 kts and ≤300 kts. 12=Airspeed is >300 kts and ≤600 kts. 13=Airspeed is >600 kts and ≤1200 kts. 14=Airspeed is >1200 kts. 15=Not assigned.
RL		1	9	X		Command, sent in UF=0, 16; solicits DF=0 reply, if "0" and DF=16 reply, if "1" (only if transponder is associated with Airborne Collision Avoidance System [ACAS] equipment). Otherwise, in UF=0, "0" solicits DF=0 reply and "1" solicits no reply. In UF=16, "0" solicits DF=16 reply and "1" solicits no reply.
RR		5	9-13	X		Contains length and content of reply requested by the interrogator. RR is part of the surveillance and Comm-A interrogations UF=4, 5, 20, 21.

RR Code	Reply Length	MB Content
0-15	Short	N/A
16	Long	Air initiated Comm-B
17	Long	Data link capability
18	Long	Aircraft Identification
19	Long	Resolution Advisories
20-31	Long	Not Assigned

NOTE: If the first bit of the RR code is '1', the decimal equivalent of the last four bits of the RR code designates the code for BDS1 in the reply (if ground initiated). BDS2 is assumed to be "0" if not specified by DI=7 and RRS.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
SD		16	17-32	X	Contains control codes, as specified by the DI field, affecting transponder protocol and is part of surveillance and Comm-A interrogations UF=4, 5, 20 and 21.
	IIS	4	17-20	X	Interrogator Identifier subfield contains the self-identification code of the interrogator and is numerically identical to the II code transmitted by the interrogator in the Mode S Only All-Call. IIS codes are assigned to interrogators and range from 0 through 15; IIS=0 is not a valid interrogator identifier for multisite purposes. IIS is sent only when DI=0, 1 or 7.
	LOS	1	26	X	Lockout subfield, if set to "1", initiates a multisite All-Call lockout to Mode S-Only All-Calls (UF=11) from the Interrogator indicated in IIS of the interrogation. If LOS is set to "0", no change in lockout state is commanded. LOS is sent only if DI=1 or 7.
	MBS	2	21-22	X	Multisite Comm-B subfield, sent when DI=1, is assigned the following codes: 0 = No Comm-B action. 1 = Comm-B reservation. 2 = Comm-B closeout.
	MES	3	23-25	X	Multisite ELM subfield, sent when DI=1, contains reservation and closeout commands for ELM as follows: 0 = No ELM action. 1 = Comm-C reservation. 2 = Comm-C closeout. 3 = Comm-D reservation. 4 = Comm-D closeout. 5 = Comm-C reservation and Comm-D closeout. 6 = Comm-C closeout and Comm-D reservation. 7 = Comm-C and Comm-D closeouts.
	RRS	4	21-24	X	Reply Request subfield, sent when DI=7, contains coding corresponding to the requested BDS2 code.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
	RSS	2	27,28	X	Reservation Status subfield, sent when DI=1, requests the transponder to report the reservation status in the UM field. The codes are: 0 = No request. 1 = Report Comm-B reservation status. 2 = Report Comm-C reservation status. 3 = Report Comm-D reservation status.
	TMS	4	29-32	X	Tactical Message subfield, sent when, DI=1 or 7, contains coding for the linking of Comm-A message segments. The codes are: 0 = No Action. 1 = Unlinked, Priority. 2 = Unlinked, Acknowledge. 3 = Unlinked, Priority, Acknowledge. 4 = Linked 1st Segment, Single ADS. 5 = Linked 1st Segment, Single ADS Priority. 6 = Linked 1st Segment, Single ADS Acknowledge. 7 = Linked 1st Segment, Single ADS, Priority, Acknowledge. 8 = Linked 1st Segment, Multiple ADS. 9 = Linked 1st Segment, Multiple ADS, Priority. 10=Linked 1st Segment, Multiple ADS, Acknowledge. 11=Linked 1st Segment, Multiple ADS, Priority, Acknowledge. 12=Second Segment. 13=Third Segment. 14=Final Segment. 15=Not Assigned.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
SL		3	9-11		X	Reports the sensitivity level the TCAS unit is currently operating at, and is a part of air-air surveillance replies, DF=0, 16. The codes are: 0 = No TCAS sensitivity level reported. 1 = TCAS operates at sensitivity level 1. 2 = TCAS operates at sensitivity level 2. 3 = TCAS operates at sensitivity level 3. 4 = TCAS operates at sensitivity level 4. 5 = TCAS operates at sensitivity level 5. 6 = TCAS operates at sensitivity level 6. 7 = TCAS operates at sensitivity level 7. **NOTE:** The SL field has no meaning for aircraft with RI=0 (no on-board capability to generate resolution advisories).
UF		5	1-5	X		The first field in all uplink formats is the transmission descriptor in all interrogations.
UM		6	14-19		X	Contains transponder status readouts in replies DF=4, 5, 20, 21.
	IDS	2	18,19		X	Identifier Designator subfield reports the type of reservation made by the interrogator identified in IIS and cooresponds with the RSS subfield of SD. Assigned coding is: 0 = No information available. 1 = Comm-B reservation active. 2 = Comm-C reservation active. 3 = Comm-D reservation active.
	IIS	4	14-17		X	Interrogator Identifier subfield reports the identity of the interrogator that has made a multisite reservation.
VS		1	6		X	Indicates, when "0", that the aircraft is airborne and, when "1" that the aircraft is on the ground. VS is a part of DF=0, 16.

Overview of Format Definitions
Table 3 (Cont)

				b5	0	0	1	1
				b6	0	1	0	1
b4	b3	b2	b1					
0	0	0	0			P	SP	0
0	0	0	1		A	Q		1
0	0	1	0		B	R		2
0	0	1	1		C	S		3
0	1	0	0		D	T		4
0	1	0	1		E	U		5
0	1	1	0		F	V		6
0	1	1	1		G	W		7
1	0	0	0		H	X		8
1	0	0	1		I	Y		9
1	0	1	0		J	Z		
1	0	1	1		K			
1	1	0	0		L			
1	1	0	1		M			
1	1	1	0		N			
1	1	1	1		O			
SP = SPACE code								

6-Bit Character Set for AIS Subfield
Table 4

APPENDIX D - AUXILIARY EQUIPMENT

Refer to 1-2-2, Figure 2 for Controls, Connectors and Indicators referenced in this apppendix.

1. Lid Assembly (Refer to Figure 1.)

   A. Antenna Shield Assembly - used with Antenna Shield Plate to cover UUT Antenna not being tested.

   B. Monopole Antenna - RF antenna used with Test Set when power accuracy is not critical and a direct connection is not convenient.

   C. AC Power Cable - used to connect ac power from an external source to AC PWR Connector (7).

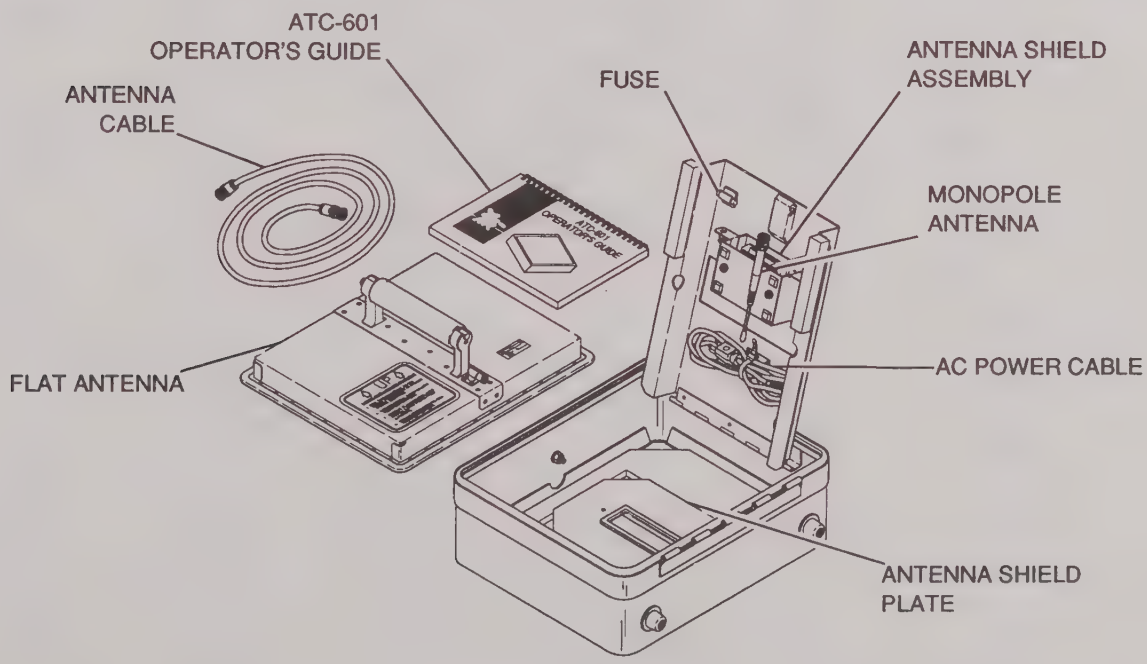
   D. Antenna Shield Plate - used with Antenna Shield Assembly to cover UUT Antenna not being tested.

   E. Flat Antenna - RF antenna used with Test Set when power accuracy is most critical.

   F. Antenna Cable - BNC to BNC coaxial cable used to connect FLAT ANTENNA Connector (22) to ANTENNA Connector (16).

   G. ATC-601 Operator's Guide - weatherproof guide for use in the ramp environment.

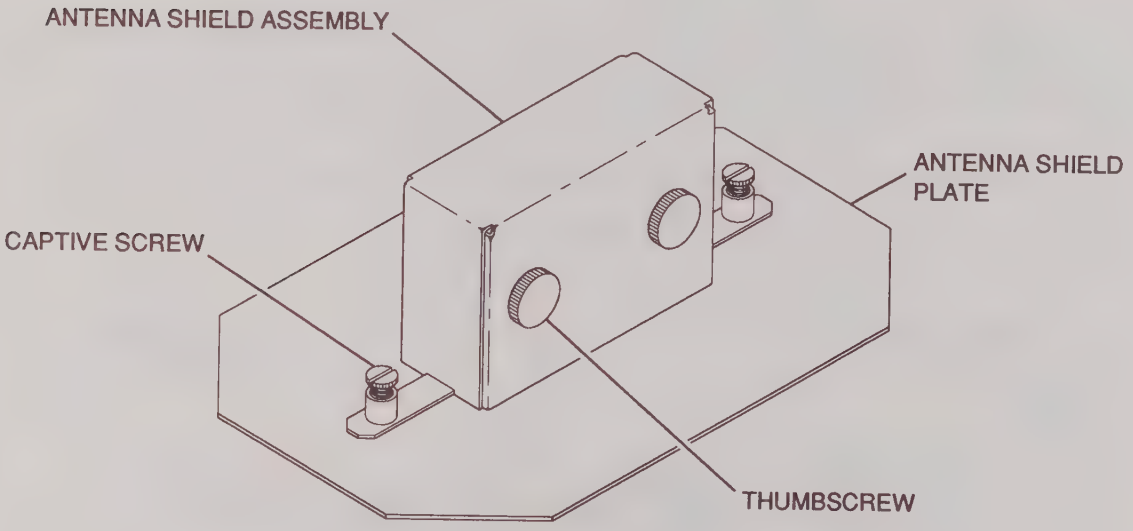
   H. Fuse - spare 1.0 Amp, 250 V Fast-Blo fuse.



Auxiliary Equipment
Figure 1

2. Antenna Shield Procedure (Refer to Figure 2.)

STEP	PROCEDURE
1.	Position Antenna Shield Assembly inside the slot in the Antenna Shield Plate, aligning captive screws into the respective screw holes.
2.	Tighten captive screws.
3.	Cover UUT Antenna with Antenna Shield. Loosen Thumbscrews if necessary.
	NOTE: It may be necessary to remove UUT Antenna Guard if access to UUT Antenna is restricted.
4.	Secure Antenna Shield by tightening thumbscrews.



Antenna Shield
Figure 2

APPENDIX E - METRIC/BRITISH IMPERIAL CONVERSION TABLE WITH NAUTICAL DISTANCE CONVERSIONS

To Convert:	Into:	Multiply By:	To Convert:	Into:	Multiply By:
cm	feet	0.03281	meters	feet	3.281
cm	inches	0.3937	meters	inches	39.37
feet	cm	30.48	m/sec	ft/sec	3.281
feet	meters	0.3048	m/sec	km/hr	3.6
ft/sec	km	1.097	m/sec	miles/hr	2.237
ft/sec	knots	0.5921	miles	feet	5280
ft/sec	miles/hr	0.6818	miles	km	1.609
ft/sec^2	cm/sec^2	30.48	miles	meters	1609
ft/sec^2	m/sec^2	0.3048	miles	nmi	0.8684
grams	ounces	0.03527	miles/hr	ft/sec	1.467
inches	cm	2.54	miles/hr	km/hr	1.609
kg	pounds	2.205	miles/hr	knots	0.8684
kg/cm^2	psi	0.0703	nmi	feet	6080.27
km	feet	3281	nmi	km	1.8532
km	miles	0.6214	nmi	meters	1853.2
km	nmi	0.5396	nmi	miles	1.1516
km/hr	ft/sec	0.9113	ounces	grams	28.34953
km/hr	knots	0.5396	pounds	kg	0.4536
km/hr	miles/hr	0.6214	psi	kg/cm^2	0.0703
knots	ft/sec	1.689	100 ft	km	3.048
knots	km/hr	1.8532	100 ft	miles	1.894
knots	miles/hr	1.1516	100 ft	nmi	1.645

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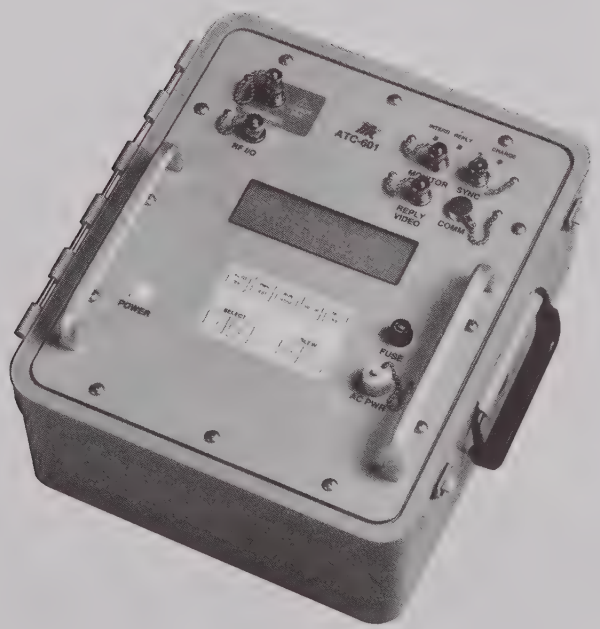
OPERATION MANUAL

ATC - 601
RAMP TEST SET



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02

OPERATION MANUAL
ATC-601

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ATC-601 RAMP TEST SET

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Screen Symbols Identification Chart	1-2-4	15

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SECTION 1 - DESCRIPTION

1. General Description and Capabilities

A. General

The ATC-601 Ramp Test Set is a ruggedized ramp tester designed for ease of use, portability, reliability and long service life. Power is derived from an internal battery. An ac input connection is provided for battery charging, bench operation or servicing use. Most accessories (Flat Antenna, Antenna Cable, AC Power Cable, Flexible Antenna, Antenna Shield, Fuse and Operator's Guide) are kept in the Storage Compartment (Case Assembly Lid). The Tripod is stored separately. Refer to Appendix D for description of accessories.

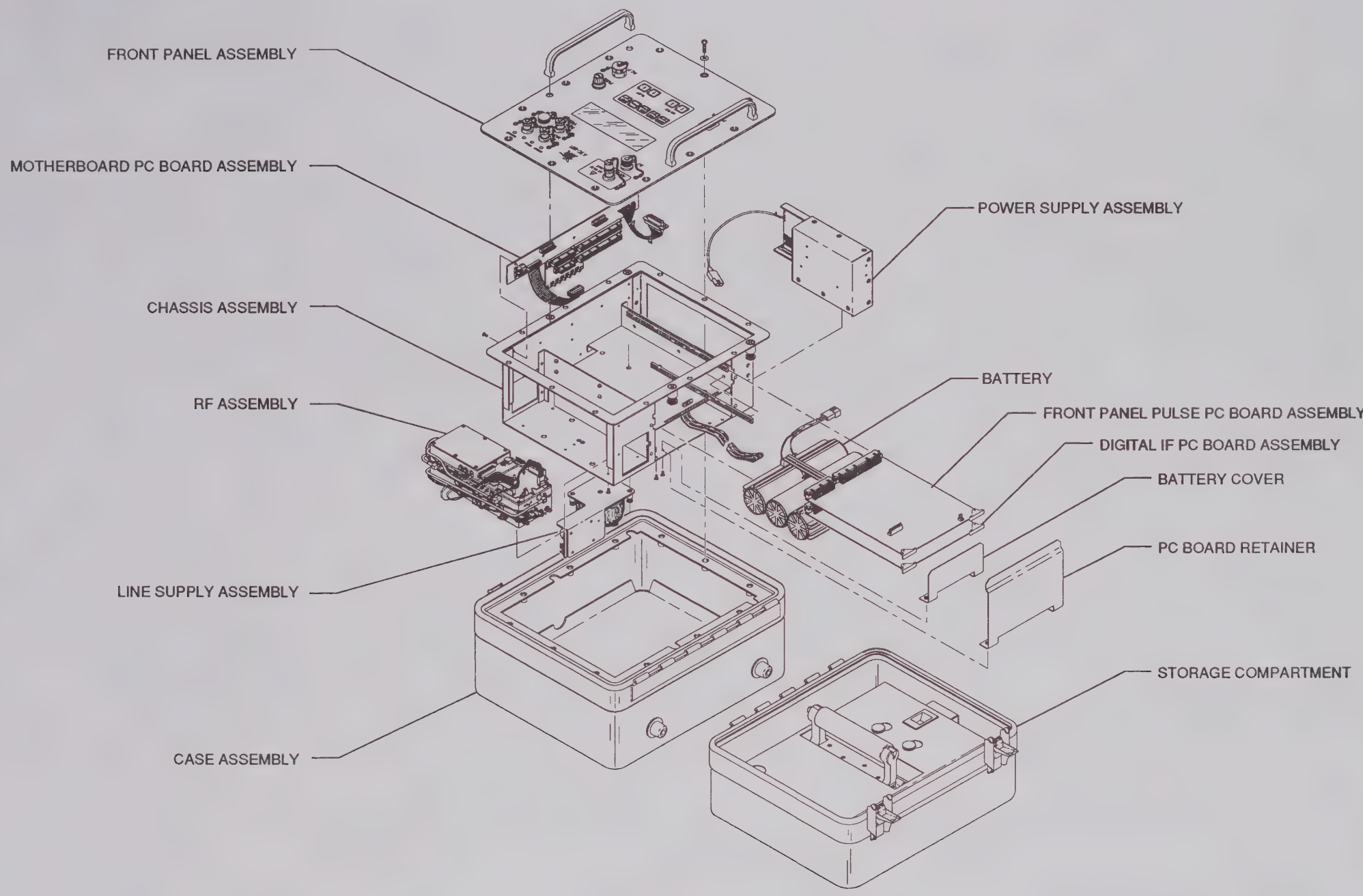
The ATC-601 Ramp Test Set provides PASSED/FAILED verification of ATCRBS and/or Mode S Transponder operation in a ramp environment. The ATC-601 is a ground or air interrogating simulator that transmits Modes A, C and S interrogations. The Test Set accurately analyzes reply pulses, provides reply pulse information and indicates failures to comply with accepted guidelines.

B. Functional Capabilities

- Accurate measurements of transponder transmitting frequency, output power and sensitivity.
- Ruggedized construction designed for the conditions encountered in the ramp environment.
- Automatic Test Sequence mode for fast and easy testing.
- Memory Storage for up to two sets of test results plus latest test results are stored, indefinitely, until replaced with new test results.
- Built-In-Test (BIT) for confidence testing and fault isolation.
- Soft-press key controls for easy operation.
- Reply pulse verification of delay, width, spacing, format and content.
- Ability to test a transponder in the aircraft from a distance of up to 300 feet (91.4 meters).
- LCD Display with automatic light sensing illumination control.
- RF I/O, Monitor, Reply Video and Sync Pulse outputs for use in bench testing.
- Internal Battery allowing up to two hours of operation before recharge.
- Automatic power shutdown after approximately 15 minutes of non-use when ac power is not connected.
- Size and usability to allow "one person" operation on the ramp.
- Serial remote operation (RS-232) through COMM Connector when Option 1 is installed.

C. Mechanical Description

The ATC-601 mechanical description is shown in 1-1-1, Figure 1.



ATC-601 Composite
Figure 1

SECTION 2 - OPERATION

1. Installation

A. General

The ATC-601 is powered by an internal battery. The Test Set contains a battery charging circuit which enables the operator to recharge the battery when connected to ac power.

NOTE: The ATC-601 can operate continuously on ac power for servicing and/or bench tests.

Refer to 1-2-2, Figure 2 for location of controls, connectors or indicators specified with an item number.

B. Battery Operation

The internal battery is equipped to power the ATC-601 for two hours of continuous use, after which time, the ATC-601 battery needs recharging. When executing the Self Test function, the DISPLAY (14) indicates whether the battery is usable or in need of recharging.

NOTE: When battery is low during operation, the ATC-601 shows "BAT" on the left side of the top line and two small block characters on the left side, below the bottom line of the DISPLAY (14).

The ATC-601 contains an automatic time-out to conserve power. If a key is not pressed within a 15-minute time period, the Test Set shuts Off (only when using battery power).

C. Battery Charging

The battery charger operates whenever ac power is applied to the Test Set and the POWER Key (11) is pressed Off. When charging, the battery reaches an 80% charge in approximately two hours. The battery should be charged every three months (minimum) or disconnected for long term nonactive storage periods of more than six months.

D. Safety Precautions

Listed are several important safety precautions which must be observed during installation and operation. IFR SYSTEMS, INC., assumes no liability for failure of customer to comply with any of the safety precautions outlined in this manual.

(1) Complying with Instructions

Operators should not attempt to operate the ATC-601 without reading and complying with instructions contained in this manual. All procedures contained herein must be performed in exact sequence and manner described.

(2) Power Cord

The power cord is equipped with standard three-prong plug which must be connected to a properly grounded three-prong wall receptacle. It is the customer's responsibility to:

- Have qualified electrician check wall receptacle(s) for proper grounding.
- Replace any standard two-prong wall receptacle(s) with properly grounded three-prong receptacle(s).

WARNING: DUE TO POTENTIAL SAFETY HAZARDS, USE OF THREE-PRONG TO TWO-PRONG ADAPTOR PLUG(S) IS NOT RECOMMENDED.

E. FAA Requirements

The Federal Aviation Administration (FAA) requires procedures for eliminating the potential for interfering with TCAS-equipped aircraft during transponder testing. Problems arise when the transponder is operating with the aircraft on the ground and the automatic altitude reporting system "pumped up." Three methods of FAA compliance are: shielding transponder antenna(s), connecting the ATC-601 directly to the transponder under test and testing in an anechoic enclosure. The Antenna Shield provides a practical way of complying with the FAA requirement when a direct connection or anechoic enclosure is not available. Refer to Appendix D3 for Antenna Shield installation. Refer to 1-2-4C and 1-2-4D for testing transponder operation when using the Antenna Shield.

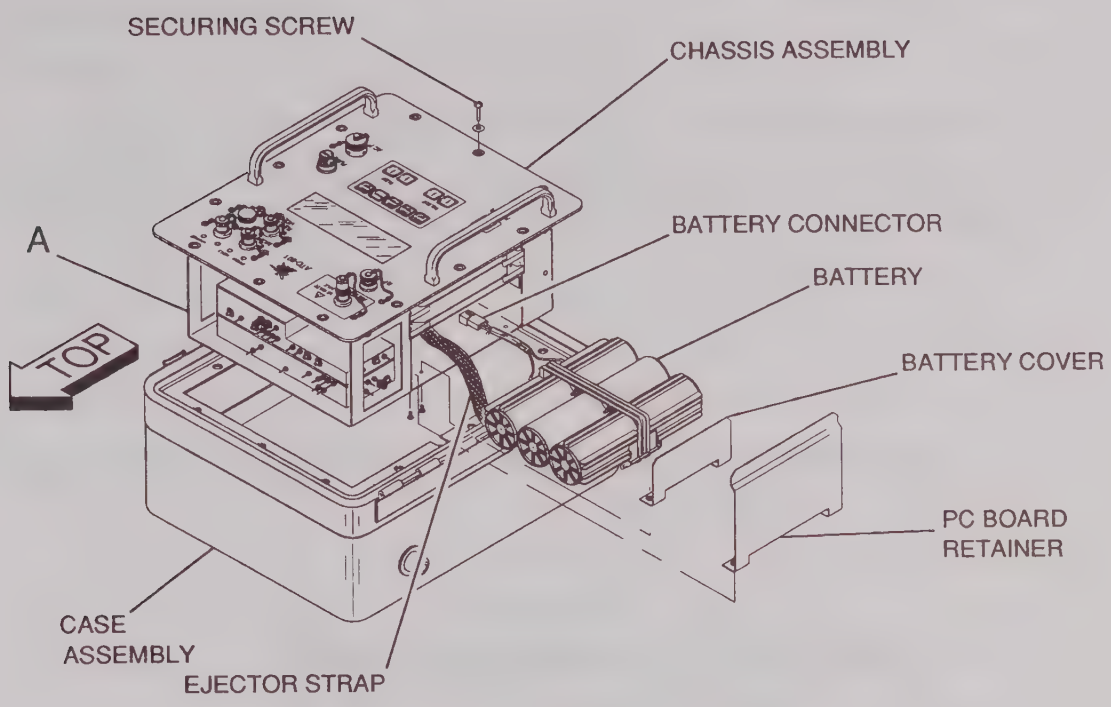
F. Battery Removal (Refer to 1-2-1, Figure 1.)

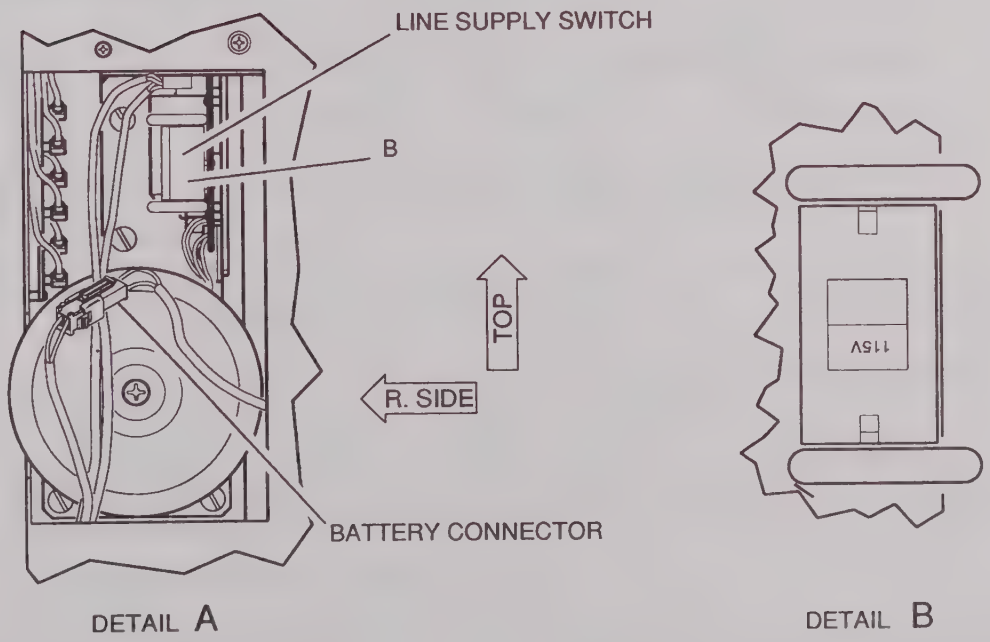
STEP	PROCEDURE

1. Verify ATC-601 is Off and not connected to ac power.
2. Remove 12 securing screws and lift Chassis Assembly from Case Assembly.

   CAUTION: REPLACING NYLON WASHERS IS RECOMMENDED TO MAINTAIN WATER RESISTANCE CAPABILITY WHEN REINSTALLING CHASSIS ASSEMBLY INTO CASE ASSEMBLY.

3. Disconnect battery connector through bottom of Chassis Assembly.
4. Remove two screws from bottom of Chassis Assembly and remove PC board retainer.
5. Remove two screws from bottom of Chassis Assembly and remove battery cover.
6. Pull ejector strap to remove battery from Chassis Assembly.





8107009

Battery Removal and Line Switch Location
Figure 1

G. Battery Recharging

STEP	PROCEDURE

1. Remove cover from AC PWR Connector (7).
2. Refer to 1-2-1, Figure 1. If power source is 103.5-129 VAC, set Line Supply Switch to 115. If power source is 207-253 VAC, set Line Supply Switch to 230.
3. Connect ac power source to AC PWR Connector (7) using AC Power Cable.
4. Verify DISPLAY (14) is Off. If DISPLAY (14) is On, press POWER Key (11).
5. Verify CHARGE Indicator (1) illuminates red.
6. Allow two hours for battery charge or until CHARGE Indicator (1) illuminates green.

H. Bench Operation

STEP	PROCEDURE

1. Place transponder (unit under test [UUT]) into Standby.
2. Remove cover from AC PWR Connector (7) on ATC-601.
3. Refer to 1-2-1, Figure 1. If power source is 103.5-129 VAC, set Line Supply Switch to 115. If power source is 207-253 VAC, set Line Supply Switch to 230.
4. Connect ac power source to AC PWR Connector (7) using AC Power Cable.
5. Press POWER Key (11) to On and verify DISPLAY (14) is illuminated.
6. Press SETUP Key (4) and select zero range using SELECT Keys (10) for item and SLEW Keys (8) for value.
7. Verify ANTENNA Connector (16) has 50 Ω load (Connector Cover) connected.
8. Connect UUT with TNC Cable to RF I/O Connector (15).
9. Switch UUT out of Standby.

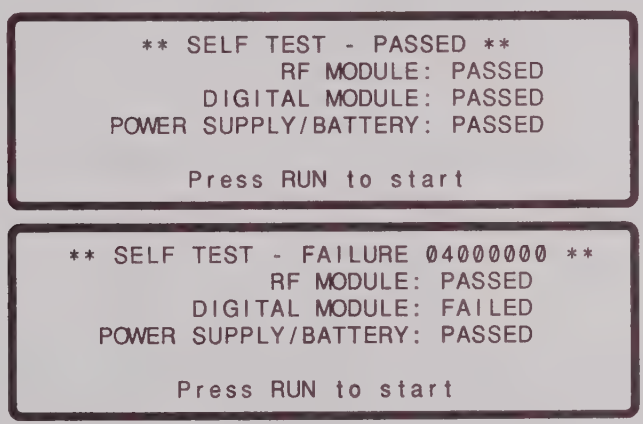
3. Performance Evaluation

A. General

The ATC-601 is equipped with a Self Test for quick performance evaluation and Diagnostics for signal verification. Self Test checks the Digital Module (Digital IF PC Board Assembly and Front Panel Pulse PC Board Assembly functions), Power Supply/Battery and RF Module (RF Assembly functions) for operational capability. Diagnostics are used to verify the ATC-601 is transmitting correct interrogations and accurately decoding replies.

Refer to 1-2-2, Figure 2 for location of controls, connectors and indicators specified with an item number.

B. Self Test (Refer to 1-2-3, Figure 4.)



Sample Self Test Screens
Figure 4

STEP	PROCEDURE

1. Press POWER Key (11).

2. Press SELF TEST Key (6) to enter Self Test screen. (Results of last Self Test are displayed.)

3. Press RUN/STOP Key (9) to initiate Self Test. (Top line displays test names while testing and indicates "PASSED" or "FAILURE" at completion. An eight-digit hexadecimal error code is displayed with failure indications. Also, a "PASSED" or "FAILED" indication is displayed for each module/assembly.)

   NOTE: ANTENNA Connector must be terminated with Connector Cover.

4. Verify all modules/assemblies passed test.

   NOTE: If a failure is indicated, refer to 1-2-3, Table 1 for error code definitions. If battery is failing, refer to 1-2-1F for Battery Recharging. If any other failure occurs, refer to ATC-601 Maintenance Manual for further testing and maintenance instructions.

TEST	GROUP	VERIFIES	FAILURE CODE (h)	RUNNING ORDER
LO Control	RF	Valid ON/OFF status	00000001	2
LO Detect	RF	LO is locked.	00000002	16
RF Detect	RF	TX level out/attenuation	00000004	17
Battery	Power Supply/ Battery	Voltage is within correct voltage range.	00000010	1
Non-Volatile RAM Battery	Power Supply/ Battery	Battery has sufficient power for RAM to retain memory.	00000020	Only on power-up
DSP Initialization	Digital	Handshake routine	00000040	18
Reply Decoder	Digital	Solicited ATCRBS reply	00000100	10
		Solicited Mode S reply	00000200	9
		Unsolicited Mode S reply (squitter)	00000400	8
IF Loop	RF	Background level (0 dB)	00020000	19
		SLS/foreground ratio (9 dB)	00100000	20
		DSP does not measure a non-existent signal.	00200000	21
UART	Digital	RS-232 loop back	00400000	12
Pulse Wrap	Digital	PULSE to DPSK timing	00800000	11
RAM	Digital	Dual Port RAM (DPR)	01000000	3
		Video RAM	02000000	4
		Non-Volatile RAM	04000000	6
		Display RAM	08000000	5
Attenuator #1	Digital	Level at endline diodes	10000000	13
Attenuator #2	Digital	Level at midline diodes	20000000	13
LO Compensation	Digital	DCXO control voltage	40000000	15
LED	Digital	Interrogation and reply drivers	80000000	7

NOTE: Multiple failures are indicated by the sum of the error codes.
NOTE: If DPR Test fails, subsequent RAM tests are not run.

Self Test Error Code Definitions
Table 1

C. Diagnostics (Refer to 1-2-3, Figure 5.)

```
** DIAGNOSTICS **
SIGNAL TYPE: ATC_C          PRF: 235
ATTENUATION: 50          ADDRESS: 3FABF2
DATA: 0050 01
INTERROGATIONS: 20     FAILURES: 0
        Press RUN to start
```

Sample Diagnostics Screen
Figure 5

CAUTION: DO NOT OPERATE DIAGNOSTICS WITH ANTENNA CONNECTED TO ATC-601 TEST SET. TRANSMISSION SIGNALS USED IN DIAGNOSTICS MAY INTERFERE WITH OTHER AREA TRANSPONDER OPERATION AND/OR VIOLATE FCC RULES AND REGULATIONS, PART 87, GOVERNING SIGNAL TRANSMISSIONS FOR LAND TEST STATIONS.

STEP	PROCEDURE

1. Press SELF TEST Key (6) to enter Self Test screen.
2. Press either of the SELECT Keys (10) to enter Diagnostics screen.
3. Connect a transponder or reply generator to RF I/O Connector (15), for testing ATC-601 reply decoder.

   NOTE: Interrogation generation may be tested by running Diagnostics Test with or without connecting anything to the ATC-601 Test Set.

4. Use SLEW Keys (8) to change values or signal type. Use SELECT Keys (10) to change items. (Cursor line indicates item selected.)

SIGNAL TYPE:	Set interrogation signal transmitted by ATC-601. (Interrogation signal is same as interrogation sent in Auto Test and applicable Single Tests.) Refer to 1-2-3, Table 2 for choice of signals.
PRF:	Set interrogation rate from 1 to 235 interrogations per second. (Mode S signals are limited to a PRF of 78. Selectable PRFs [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 20, 21, 24, 26, 29, 34, 39, 47, 59, 78, 118 or 235] are rounded quotients of 235 divided by whole numbers.)
ATTENUATION:	Set attenuation of incoming signal/ATC-601 output from 0 to 100 steps with each step representing 0.5 dB (0 = no attenuation).
ADDRESS:	Set address sent in Mode S interrogations. (Address is changeable in three separate sections, each ranging from 00 to FF [hexadecimal].)

STEP PROCEDURE

5. Press RUN/STOP Key (9) to initiate test and display following information:

DATA: Most recent reply information in hexadecimal form. Refer to Appendix C for reply definition. Data field is followed by a two-digit, hexadecimal status byte. Only the least significant digit (LSD) is used. Status definition is:

For ATCRBS, LSD is:
0, 2, 4, 6, 8, A, C or E = Unsolicited reply.
1, 3, 5, 7, 9, B, D or F = Solicited reply.

For Mode S, LSD is:
0, 4, 8 or C = Invalid, Unsolicited reply.
1, 5, 9 or D = Valid, Unsolicited reply.
2, 6, A or E = Invalid, Solicited reply.
3, 7, B or F = Valid, Solicited reply.

INTERROGATIONS: Number of interrogations transmitted.

FAILURES: Number of interrogations for which no reply was received.

6. Press RUN/STOP Key (9) to stop test.

SIGNAL TYPE	DEFINITION	USED IN
DSP_MEASURE	(not an output signal) Measures Input (ADC counts in decimal)	ATC-601 Calibration
CW_M5	Continuous Wave at -5 dB	ATC-601 Calibration
CW	Continuous Wave at 0 dB (power level compensates to attenuation)	ATC-601 Calibration
CW_P4	Continuous Wave at +4 dB	ATC-601 Calibration
ATC_A_BCKGND	ATCRBS Mode A (background level)	Test operations for automatic attenuation control
ATC_C_BCKGND	ATCRBS Mode C (background level)	MTL Difference Test
ITM_MODES_C	Intermode (Mode C/S)	ATCRBS/Mode S All-Call

Diagnostics Signal Definitions
Table 2

4. General Operating Procedures

This section contains operating instructions for the ATC-601 Ramp Test Set. The operating instructions contain general procedures, identifying the controls, connectors, indicators and Display screens used for the individual ATC-601 test functions. For specific Unit Under Test (UUT) Procedures, refer to the appropriate UUT Manual.

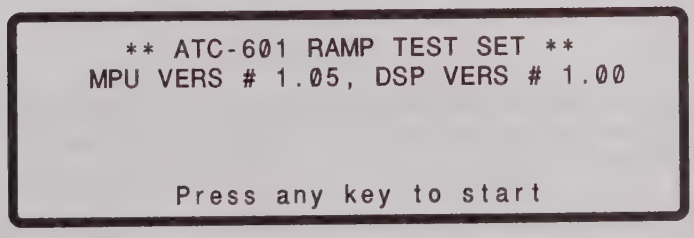
Refer to 1-2-2, Figure 2 for location of controls, connectors and indicators specified with an item number.

The purpose of the ATC-601 Ramp Test Set is to test the operation and installation of an ATCRBS or Mode S transponder in a ramp environment. There are four basic functions that allow the Test Set to do this:

- Setup allows operator to set various parameters used in testing, remote operation and memory storage.
- Auto Test runs through a group of tests checking function and operation of the transponder.
- Single Test allows the user to run through any one of 19 individual tests.
- Power Test accurately measures Peak Pulse Power (Effective Radiated Power [ERP]) and Receiver Sensitivity (Minimum Triggering Level [MTL]) of the transponder, even when direct connection with UUT is not possible.

A. Start-up

Pressing the ATC-601 Test Set POWER Key (11) causes a Start-up screen to appear on the DISPLAY (14). Information contained in this screen indicates software versions of the Microprocessing Unit (MPU) and Digital Signal Processor (DSP) used in that particular Test Set.



Sample Start-up Screen
Figure 6

B. Setup

The ATC-601 has three Setup Menus. Setup#1 Menu contains the parameters required for accurate test calculations. Setup#2 contains remote operation parameters. Setup#3 Menu contains memory operation parameters.

(1) Setup#1 Menu (Test Operation)

```
          ** SETUP#1 MENU **
   UUT ANTENNA: RANGE HEIGHT
          TOP =  110     18
       BOTTOM =   45      8
     SELECTED =  BOTTOM
GAIN_1030=11.5 GAIN_1090=12.0 LOSS=1.0
```

```
          ** SETUP#1 MENU **
   UUT ANTENNA: RANGE HEIGHT
          TOP =  110     18
       BOTTOM =   45      8
     SELECTED =  TOP
GAIN_1030=11.5 GAIN_1090=12.0 LOSS=1.0
```

```
          ** SETUP#1 MENU **
   UUT ANTENNA: RANGE HEIGHT
          TOP =  250     18   **ERROR**
       BOTTOM =   45      8
     SELECTED =  TOP
GAIN_1030=11.5 GAIN_1090=12.0 LOSS=1.0
```

```
          ** SETUP#1 MENU **
   UUT ANTENNA: RANGE HEIGHT
          TOP =  110     18
       BOTTOM =    0      8 * DIRECT *
     SELECTED =  BOTTOM
GAIN_1030= 0.0 GAIN_1090= 0.0 LOSS=1.0
```

Sample Setup#1 Menu Screens
Figure 7

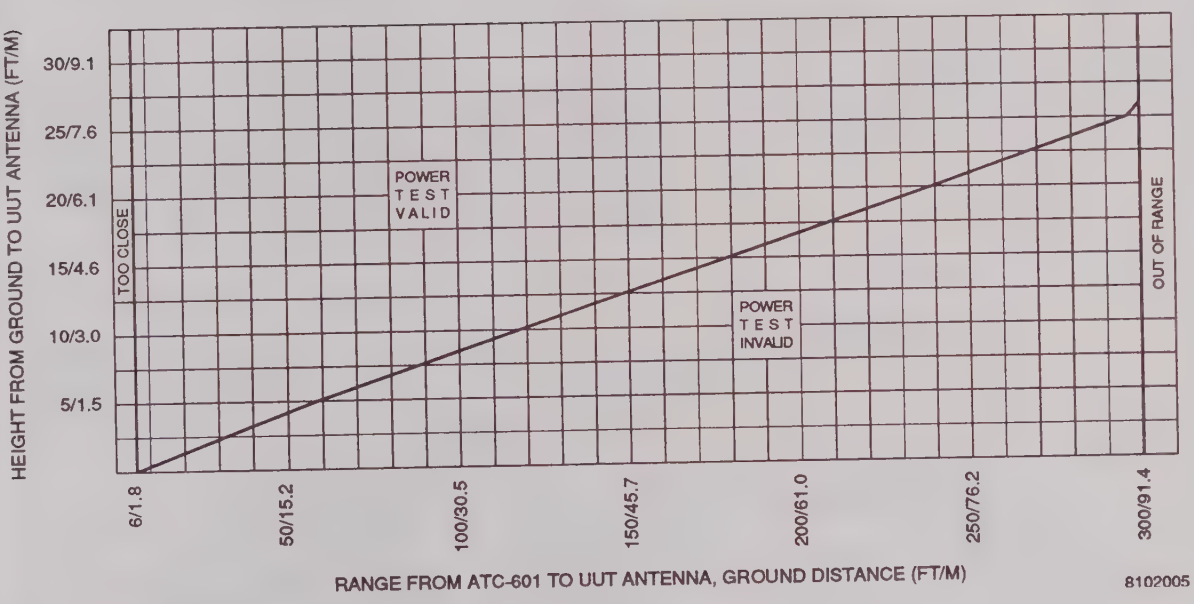
The Setup #1 Menu contains range, height, ATC-601 antenna gain and cable loss parameters used in calculating and verifying reply delay and power measurements.

NOTE: Enter Setup#1 Menu information before conducting test operations.

STEP	PROCEDURE

1. Position ATC-601 Test Set according to 1-2-4, Figure 8.

   NOTE: For best Power Test results, aircraft, buildings, vehicles and other large objects should not be between Test Set and aircraft with Unit Under Test (UUT). Refer to 1-2-4, Figure 34.



ATC-601 Position Chart
Figure 8

STEP PROCEDURE

2. Press SETUP Key (4) once (three times from Setup#2 Menu or twice from Setup#3 Menu) to enter Setup#1 Menu. (ATC-601 displays information from last Setup#1 Menu.)

3. Enter information using SLEW Keys (8) to change values and SELECT Keys (10) to change parameters. (Cursor line indicates parameter selected.)

   NOTE: The SLEW Keys (8) have different rates of change according to item and the way keys are pressed. Press and release a key to change a value by one foot. Press and hold a key to change Range values in ten foot increments and Height values in five foot increments.

   Set following parameters:

   RANGE: Ground distance from ATC-601 to UUT Antenna, in feet. If ATC-601 is not within effective range per Figure 8, DISPLAY (14) indicates an error and shows "BAD SETUP!" message in top line. Set to 0 for direct connection (indicated on DISPLAY [14]). Set to >0 when using antenna.

   HEIGHT: Distance from ground to UUT Antenna, in feet.

   SELECTED: UUT Antenna tested in Auto, Single and Power Tests. Selection determines which set of Range and Height values are used for Auto, Single and Power Test calculations.

   NOTE: Actual UUT Antenna tested depends upon shielding or disconnecting the UUT Antenna not being tested.

   GAIN 1030/GAIN 1090: Gain in dBi, of Test Set antenna at 1030 MHz and 1090 MHz (noted on Flat Antenna).

   LOSS: Coaxial Cable Loss in dB, of ATC-601 antenna or direct connect cable (noted on coaxial tag).

4. Press any key to exit Setup#1 Menu.

(2) Setup#2 Menu (Remote Operation)

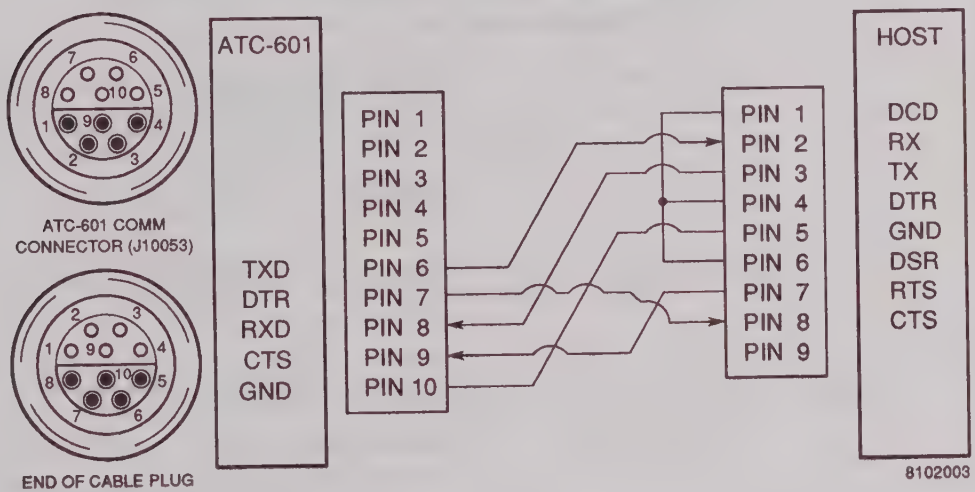
```
          ** SETUP#2 MENU **
BAUD RATE  = 9600     REMOTE ECHO    = ON
DATA BITS  = 8        PREFIX STRING  = ON
STOP BITS  = 1        DUMP TEST DATA = 0
PARITY     = NONE      Press RUN to send
HANDSHAKE  = NONE      data to COMM port!
```

Sample Setup#2 Menu Screen
Figure 9

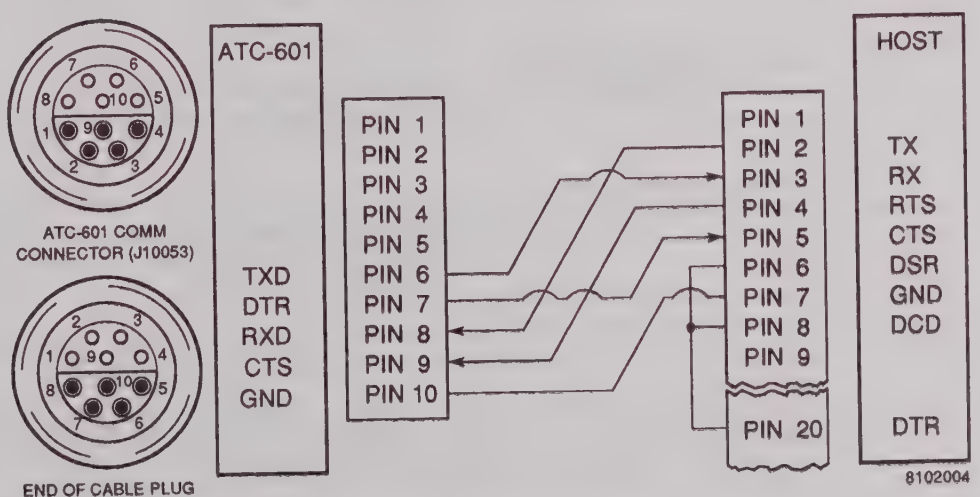
The Setup #2 Menu contains RS-232 interface parameters used for data dumps and serial remote operation (only with Option 1 installed) through the COMM Connector (3). Refer to Appendix F for remote operation commands.

STEP	PROCEDURE

1. Connect Host System Comm Connector to ATC-601 COMM Connector (3) according to 1-2-4, Figure 10 for 9-Pin operation or 1-2-4, Figure 11 for 25-Pin operation.



ATC-601 - Host Cable Connections (9-Pin)
Figure 10



ATC-601 - Host Cable Connections (25-Pin)
Figure 11

NOTE: A PC, using Terminal Emulation Sofware, or RS-232 Terminal can be used as the Host System.

STEP PROCEDURE

2. Press SETUP Key (4) twice (once from Setup#1 Menu or three times from Setup#3 Menu) to enter Setup#2 Menu. ATC-601 displays information from last Setup#2 Menu.

3. Enter information using SLEW Keys (8) to change values and SELECT Keys (10) to change parameters. (Cursor line indicates parameter selected.)

   Set following parameters:

   BAUD RATE: Baud Rate in bps (110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200 or 38400). Default is 9600.

   DATA BITS: Number of data bits per word (7 or 8). Default is 8.

   STOP BITS: Number of stop bits per word (1 or 2). Default is 1.

   PARITY: Parity check mode (NONE, ODD, EVEN, MARK or SPACE). Default is NONE.

   HANDSHAKE: Handshake mode (NONE, CTS [one-way hardware], CTS/DTR [two-way hardware] or Xon/Xoff [software]). Default is Xon/Xoff.

   REMOTE ECHO: Remote echo status (ON to enable or OFF to disable), only shown if Option 1 is installed. Default is ON.

   PREFIX STRING: Reply prefix status (ON to add prefix strings to remote operation replies for definition or OFF). Default is ON.

   DUMP TEST DATA: Test data to transmit to Host System (0 for active test data, 1 for test data stored in Memory Location 1; or 2 for test data stored in Memory Location 2).

   - Press RUN/STOP Key (9) with cursor located in DUMP TEST DATA: field to download test data. (A period displayed to the right of the test data selection indicates the download has occurred.)

   - Refer to TEST:ALL? query in Appendix F for test data definition. (Test data is sent in same format as in TEST:ALL? query, except all semicolons are replaced with <CrLf> line terminators.)

4. Press any key to exit Setup#2 Menu.

(3) Setup#3 Menu (Memory Operation)

```
          ** SETUP#3 MENU **
POWER (ERP) UNITS = WATTS
DIVERSITY TEST    = ON
RECALL TEST DATA  = 1
STORE TEST DATA   = 1.
Change store/recall field then press RUN
```

Sample Setup#3 Menu Screen
Figure 12

The Setup #3 Menu contains Effective Radiated Power (ERP) units, Diversity Test performance control and memory operation parameters.

STEP PROCEDURE

1. Press SETUP Key (4) three times (or twice from Setup#1 Menu or once from Setup#3 Menu) to enter Setup#3 Menu. ATC-601 displays information from last Setup#3 Menu.

2. Enter information using SLEW Keys (8) to change values and SELECT Keys (10) to change parameters. (Cursor line indicates parameter selected.)

   Set following parameters:

   POWER (ERP) UNITS: ERP measurement units used in Power Test (dBm, dBw or WATTS). Default is dBm.

   DIVERSITY TEST: Control over performing Diversity (isolation) Test during Auto Test (ON to perform Diversity Test or OFF [Diversity Test displays "NOT RUN"] to not perform Diversity Test). Default is ON.

   RECALL TEST DATA: Test data to recall from memory (1 for test data stored in Memory Location 1; or 2 for test data stored in Memory Location 2).

   - Press RUN/STOP Key (9) to recall test data. (A period displayed to the right of the test data selection indicates recall has occurred.)

   STORE TEST DATA: Memory Location for storing current test data (1 to store test data in Memory Location 1; or 2 to store test data in Memory Location 2).

   - Press RUN/STOP Key (9) to store current test data. (A period displayed to the right of the Memory Location selection indicates the store has occurred, overwriting any previously stored test data.)

3. Press any key to exit Setup#3 Menu.

C. Auto Test

(1) Description

The Auto Test determines operational transponder modes (A, C and/or S). The Test Set interrogates at a level 4 dB above MTL. After performing the Auto Test, the ATC-601 stores the information in battery backed up memory. Auto Test runs through the following 21 tests:

TEST	DESCRIPTION

0. Mode Test

Identifies modes of operation. Interrogations are made in Modes A, C and S (Uplink Format 11) to determine which modes the transponder replies to. These are the modes tested during the Auto Test sequence.

1. Reply Delay

Interrogates with valid modes and verifies reply delay minus range delay (average of best 8 of 13 replies) equals:

- 128.00 µs (±0.25 µs) for Mode S.
- 128.00 µs (±0.50 µs) for Intermode (All-Call)
- 3.00 µs (±0.50 µs) for ATCRBS.

NOTE: Range delay is 2.03 ns/ft (6.67 ns/m), calculated from the values in the Setup Menu.

2. Reply Jitter

Interrogates with valid modes and verifies, using best 24 of 39 replies, reply jitter (changes in reply delay) is less than or equal to:

- 0.08 µs for Mode S.
- 0.10 µs for Intermode (All-Call) and ATCRBS.

3. ATCRBS Reply

Interrogates with ATCRBS (Modes A and C) interrogations and verifies:

- F_1 to F_2 spacing is 20.3 µs (±0.10 µs).
- F_1 and F_2 pulse width between the 0.5 amplitude points on the leading and trailing edge is 0.45 µs (±0.10 µs).

TEST DESCRIPTION

4. SLS Level

NOTE: Because interrogation with SLS at -9 dB is sent at MTL plus 12 dB, SLS Test must be run within 95 feet (28.96 meters) of UUT Antenna being tested.

Interrogates with valid ATCRBS interrogations including P_2 pulse. Interrogations are conducted with P_2 level at -9 dB and then again at 0 dB. Test verifies:

- Transponder does not reply when P_2 level is at 0 dB (UUT is suppressed).
- Transponder replies when P_2 level is at -9 dB (UUT is not suppressed).

5. ATCRBS Only All-Call

Interrogates with an ATCRBS only All-Call and verifies Mode S transponders do not reply.

6. Mode S All-Call

Interrogates with the ATCRBS (Mode A)/Mode S All-Call. Address received in Downlink Format (DF) 11 is then used in an Uplink Format (UF) 4 interrogation to solicit a DF4 reply. The address received is decoded and compared with the address sent.

7. Invalid Address

Transmits Mode S interrogations using two addresses different from the address determined by the Mode S All-Call, UF11. Test verifies no reply is received. Addresses used are one greater and 256 greater than the correct address.

8. SPR On/Off

Transmits a Mode S interrogation with the Synchronous Phase Reversal (SPR) On, verifying correct reply is received. Then same interrogation is sent again with the SPR Off, verifying no reply is received.

9. Mode S UF0

Interrogates with Mode S Uplink Format 0 (Short air to air surveillance, ACAS) verifying reply is received that has correct altitude (compared with Mode C altitude), address (compared with Mode Test address) and format.

TEST DESCRIPTION

10. Mode S UF4

    Interrogates with Mode S UF4 (Surveillance, altitude request), verifying reply is received that has correct altitude (compared with Mode C altitude), address (compared with Mode Test address) and format.

11. Mode S UF5

    Interrogates with Mode S UF5 (Surveillance, identity request) verifying reply is received that has correct identity (compared with Mode A identity), address (compared with Mode Test address) and format.

12. Mode S UF11

    Interrogates with Mode S UF11, verifying reply is received that has correct address (compared with Mode Test address) and format.

13. Mode S UF16

    Interrogates with Mode S UF16 (Long air to air surveillance, ACAS), verifying reply, if received, has correct altitude (compared with Mode C altitude), address (compared with Mode Test address) and format. No reply to UF16 does not fail Mode S in Auto Test.

14. Mode S UF20

    Interrogates with Mode S UF20 (Comm A, altitude request) verifying reply received has correct altitude (compared with Mode C altitude), address (compared with Mode Test address) and format. No reply to UF20 does not fail Mode S in Auto Test.

15. Mode S UF21

    Interrogates with Mode S UF21 (Comm A, identity request) verifying reply received has correct identity (compared with Mode A identity), address (compared with Mode Test address) and format. No reply to UF21 does not fail Mode S in Auto Test.

16. Squitter

    Verifies squitters are received from the UUT every 0.8 to 2.4 seconds. ATC-601 only runs Squitter Test when testing Mode S transponders.

17. Frequency

    Verifies frequency of transponder is 1090 MHz (±3 MHz). The ATC-601 displays frequency in the Auto Test screen.

18. Diversity

    Verifies diversity isolation (power level difference between UUT "On" antenna squitters and "Off" antenna squitters) is greater than or equal to 20 dB. Diversity isolation is displayed in Auto Test screen.

TEST DESCRIPTION

NOTE: To insure ≥ 20 dB dynamic range for Diversity Test, test must be run within 50 feet (15.24 meters) of UUT Antenna being tested.

19. MTL Difference

    Verifies MTL of Mode A interrogations equals MTL of Mode C interrogations (±1.0 dB).

20. Power

    NOTE: A special procedure (refer to 1-2-4E) reduces the effects of multipath when measuring power over the air.

    Verifies transponder:

    - ERP is greater than 48.5 dBm and less than 57.0 dBm.
    - MTL is -73.0 dBm (±4.0 dB).

(2) Direct Connect Procedure (Refer to 1-2-4, Figure 13.)

STEP PROCEDURE

1. Connect UUT to ATC-601 RF I/O Connector (15).

   CAUTION: TO PREVENT DAMAGE TO ATC-601, DO NOT CONNECT UUT TO ANTENNA CONNECTOR WITH ATC-601 SET FOR DIRECT CONNECT.

2. Set Setup #1 Menu Range to ***0***.

3. Press AUTO TEST Key (13) to enter Auto Test screen. (The ATC-601 shows the results of the last Auto Test on the DISPLAY [14].)

4. Press RUN/STOP Key (9) or ANTENNA PUSH BUTTON Switch (21) (if Flat Antenna is being used) to run Auto Test. ("TEST RUNNING" and asterisks in bottom line of DISPLAY [14] indicate test is running.)

5. Press RUN/STOP Key (9) at any time to stop test (non-resumable). (Otherwise, Auto Test runs until all tests are complete.)

6. Verify modes (A, C and/or S) tested, passed or failed as indicated on DISPLAY (14). Verify UUT frequency, power measurements and diversity isolation as indicated on DISPLAY (14). If any test section fails or more information is needed, refer to 1-2-4D for Single Test and/or 1-2-4E for Power Test.

(3) "Over the Air" Ground Test Procedure (UUT aircraft altitude reporting system ≤airfield altitude) (Refer to 1-2-4, Figure 13.)

STEP	PROCEDURE

1. Connect Test Set Antenna to ATC-601 ANTENNA Connector (16). Position Test Set Antenna facing UUT Antenna at Setup#1 Menu Range.

2. Either shield with Antenna Shield (refer to Appendix D) or disconnect and terminate UUT Antenna not being tested. Deactivate other area transponders or position transponders at least three times the Setup#1 Menu Range from the Test Set Antenna.

3. Press AUTO TEST Key (13) to enter Auto Test screen. (The ATC-601 shows the results of the last Auto Test on the DISPLAY [14].)

4. Press RUN/STOP Key (9) or ANTENNA PUSH BUTTON Switch (21) (if Flat Antenna is being used) to run Auto Test. ("TEST RUNNING" and asterisks in bottom line of DISPLAY [14] indicate test is running.)

5. Press RUN/STOP Key (9) or ANTENNA PUSH BUTTON Switch (21) (if Flat Antenna is being used) at any time to stop test (non-resumable). (Otherwise, Auto Test runs until all tests are complete.)

6. Verify modes (A, C and/or S) tested, passed and failed as indicated on DISPLAY (14). Verify UUT frequency, power measurements and diversity isolation as indicated on DISPLAY (14). If any test section fails or more information is needed, refer to 1-2-4D for Single Test and/or 1-2-4E for Power Test.

(4) "Over the Air" Simulated Altitude Test Procedure (UUT aircraft altitude reporting system >airfield altitude ["pumped up"]) (Refer to 1-2-4, Figure 13.)

STEP	PROCEDURE

1. Connect Test Set Antenna to ATC-601 ANTENNA Connector (16).

2. Shield UUT antenna being tested with Antenna Shield. Refer to Appendix D. Either shield with Antenna Shield or disconnect and terminate UUT Antenna not being tested. Deactivate other area transponders or position transponders >50 feet (15.24 meters) from the Test Set Antenna.

   NOTE: The Antenna Shield causes failure indications for Diversity, MTL Difference and Power Tests. The Antenna Shield may cause failure indications for the Frequency test. Such indications may be disregarded. Frequency, Diversity, MTL Difference and Power tests are verified without the Antenna Shield.

3. Position Flat Antenna ≤20 feet (6.1 meters) from transponder antenna being tested. Adjust Setup#1 Menu accordingly.

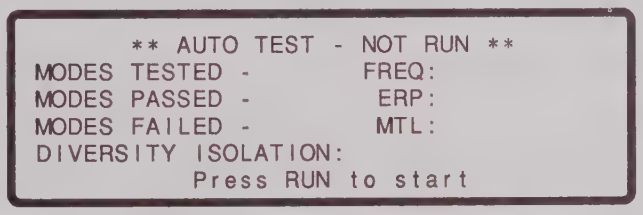
4. Press AUTO TEST Key (13) to enter Auto Test screen. (The ATC-601 shows the results of the last Auto Test on the DISPLAY [14].)

STEP PROCEDURE

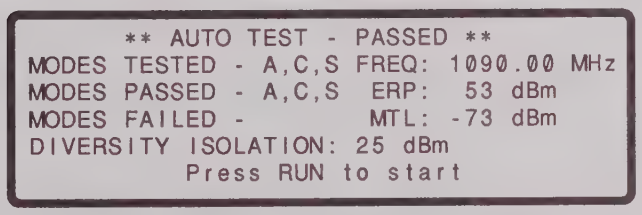
5. Press RUN/STOP Key (9) or ANTENNA PUSH BUTTON Switch (21) (if Flat Antenna is being used) to run Auto Test. ("TEST RUNNING" and asterisks in bottom line of DISPLAY [14] indicate test is running.)

6. Press RUN/STOP Key (9) or ANTENNA PUSH BUTTON Switch (21) (if Flat Antenna is being used) at any time to stop test (non-resumable). (Otherwise, Auto Test runs until all tests are complete.)

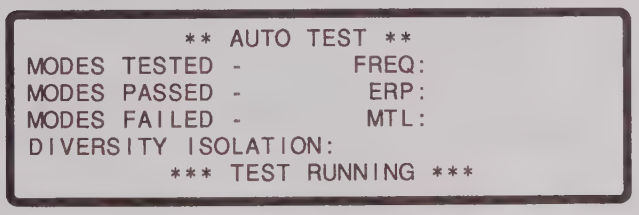
7. Verify modes (A, C and/or S) tested, passed or failed as indicated on DISPLAY (14). If any test section fails or more information is needed, refer to 1-2-4D for Single Test and/or 1-2-4E for Power Test.



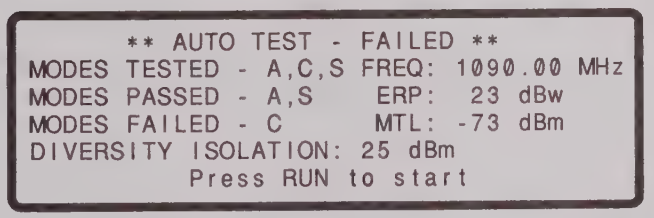
8117004


** AUTO TEST - PASSED **
MODES TESTED - A,C,S FREQ: 1090.00 MHz
MODES PASSED - A,C,S ERP: 53 dBm
MODES FAILED - MTL: -73 dBm
DIVERSITY ISOLATION: 25 dBm
Press RUN to start

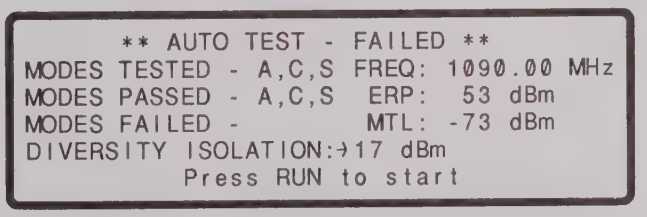
8117005



8117006


** AUTO TEST - FAILED **
MODES TESTED - A,C,S FREQ: 1090.00 MHz
MODES PASSED - A,S ERP: 23 dBw
MODES FAILED - C MTL: -73 dBm
DIVERSITY ISOLATION: 25 dBm
Press RUN to start

8117098


** AUTO TEST - FAILED **
MODES TESTED - A,C,S FREQ: 1090.00 MHz
MODES PASSED - A,C,S ERP: 53 dBm
MODES FAILED - MTL: -73 dBm
DIVERSITY ISOLATION: 17 dBm
Press RUN to start

8117008

Sample Auto Test Screens
Figure 13

D. Single Test

If more information is needed, the operator is able to view or rerun specific tests. The following paragraphs contain Single Test procedure, information and sample Display screens associated with each test. All tests are the same as those run in the Auto Test. Each Single Test runs a Mode Test first to determine valid transponder modes to be tested. Unlike Auto Test, once initiated, each Single Test continues running until RUN/STOP Key (9) is pressed again. Display screen values are expressed in decimal except for ID codes which are expressed in octal and most Mode S field values which are expressed in hexadecimal (downlink format [DF] and altitude code [AC] are expressed in decimal, while identity code [ID] is expressed in octal). Top line of DISPLAY (14) indicates "PASSED", "FAILED", "NOT RUN" or "NO REPLY" for that particular test. Refer to 1-2-4, Table 3 for Screen Symbols Identifications. Refer to Appendix C for signal formats and number system conversions.

(1) General Procedure

STEP	PROCEDURE

1. Perform the following according to desired test setup:

   - If direct connect is desired, perform Steps 1 through 3 of 1-2-4C(2).
   - If "Over the Air" Ground Test with UUT aircraft altitude reporting system ≤airfield altitude is desired, perform Steps 1 through 3 of 1-2-4C(3).
   - If "Over the Air" Simulated Altitude Test with UUT aircraft altitude reporting system >airfield altitude is desired (ATCRBS Reply, Mode S UF0, Mode S UF4 and/or Mode S UF16 Tests), perform Steps 1 through 4 of 1-2-4C(4).

2. Use SELECT Keys (10) to go from Auto Test screen to each Single Test. (Results from last test run, Auto or Single, are shown on DISPLAY [14]).

3. Press RUN/STOP Key (9) or ANTENNA PUSH BUTTON Switch (21) (if Flat Antenna is being used) to initiate test.

4. Press RUN/STOP Key (9) or ANTENNA PUSH BUTTON Switch (21) (if Flat Antenna is being used) to stop test.

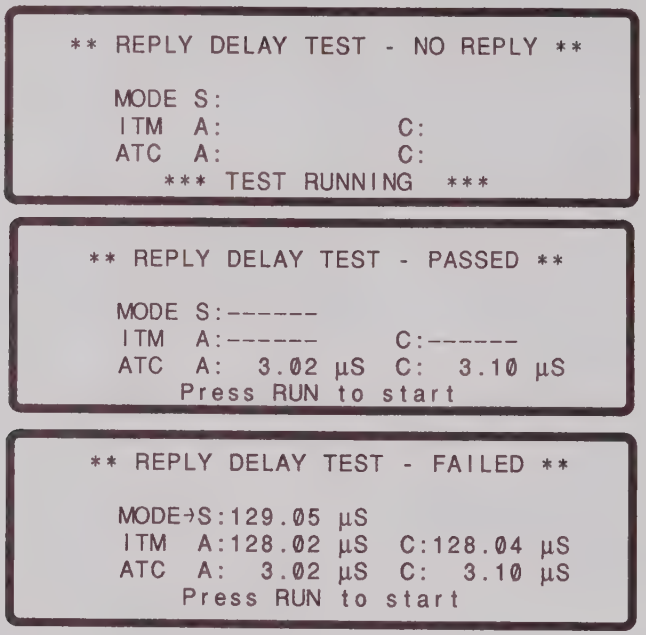
(2) Single Test Definitions

SYMBOL	LOCATION	INDICATES
→	Before item line	Error in item
####	Numerical data fields	Data string too large for data field
++++	Pwr, Freq or Diversity line	Invalid data
****	Power Values Line	Variance due to excessive multipath
** TEST RUNNING **	Bottom line	Test is running
[ ]	ATCRBS Altitude line Squitter Address line Mode S All-Call Address line	Data in Octal form
▪	Before Power Test line	UUT Antenna selected
■■	Left Side, Below Bottom Line	Battery is Low
BAT	Left Side, Top Line	

Screen Symbols Identification Chart
Table 3

1. Reply Delay (Refer to 1-2-4, Figure 14.)

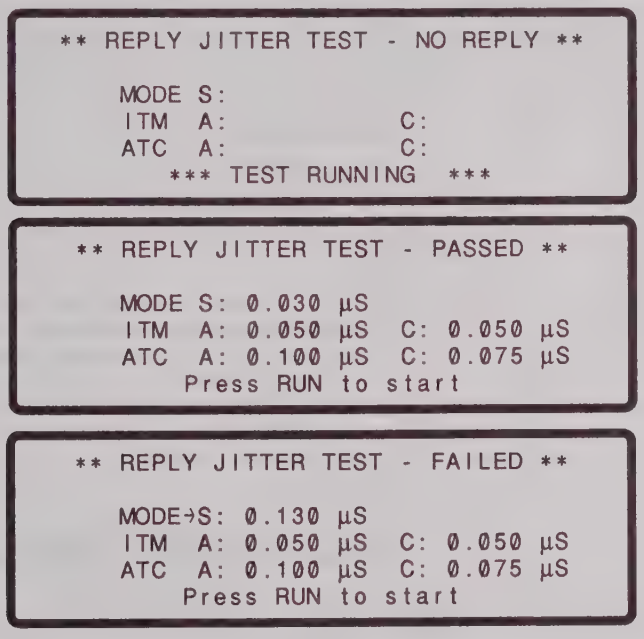
   Interrogates with Modes A, C, S and ATCRBS/Mode S All-Call (Intermode [ITM]); verifying reply delay minus range delay is 128 µs (±0.25 µs) for Mode S, 128 µs (±0.50 µs) for ITM and 3.00 µs (±0.50 µs) for ATCRBS modes. Range delay is 2.03 ns/ft (6.67 ns/m) and is calculated using range values established in Setup#1 Menu. Reply delay times are indicated on the DISPLAY (14). Only Mode S is looked at with ITM interrogation.


** REPLY DELAY TEST - NO REPLY **
MODE S:
ITM A: C:
ATC A: C:
*** TEST RUNNING ***
** REPLY DELAY TEST - PASSED **
MODE S:------
ITM A:------ C:------
ATC A: 3.02 µS C: 3.10 µS
Press RUN to start
** REPLY DELAY TEST - FAILED **
MODE→S:129.05 µS
ITM A:128.02 µS C:128.04 µS
ATC A: 3.02 µS C: 3.10 µS
Press RUN to start

Sample Reply Delay Test Screens
Figure 14

2. Reply Jitter (Refer to 1-2-4, Figure 15.)

   Interrogates with Modes A, C, S and ATCRBS/Mode S All-Call (ITM); verifying reply jitter is ≤0.08 µs for Mode S and ≤0.1 µs for ATCRBS and ITM modes. Reply jitter values (difference between shortest and longest reply delay) are indicated on DISPLAY (14).


** REPLY JITTER TEST - NO REPLY **
MODE S:
ITM A: C:
ATC A: C:
*** TEST RUNNING ***
** REPLY JITTER TEST - PASSED **
MODE S: 0.030 µS
ITM A: 0.050 µS C: 0.050 µS
ATC A: 0.100 µS C: 0.075 µS
Press RUN to start
** REPLY JITTER TEST - FAILED **
MODE→S: 0.130 µS
ITM A: 0.050 µS C: 0.050 µS
ATC A: 0.100 µS C: 0.075 µS
Press RUN to start

Sample Reply Jitter Test Screens
Figure 15

3. ATCRBS Reply (Refer to 1-2-4, Figure 16.)

Interrogates with Modes A and C, verifying F_1 to F_2 spacing is 20.3 µs (±0.10 µs) and F_1/F_2 pulse widths are 0.45 µs (±0.10 µs). F_1 to F_2 spacing, F_1 width and F_2 width values are indicated on DISPLAY (14). Mode A identity (ID) code and Mode C altitude are also displayed. If Special Position Identification Pulse (SPI) is present, "ID" is displayed before Mode A code. ALT field blanks out if invalid input (no C bit or C_1 and C_4 are on at the same time) is received. The 4-digit octal code, shown regardless of validity, displays the Mode C information as follows (MSD to LSD): $A_4,A_2,A_1/B_4,B_2,B_1/C_4,C_2,C_1/D_4,D_2,D_1$.

```
  ** ATCRBS REPLY TEST - NO REPLY **
F1 TO F2 SPACING A:           C:
F1 PULSE WIDTH   A:           C:
F2 PULSE WIDTH   A:           C:
CODE=            ALT=
          *** TEST RUNNING ***
```

```
    ** ATCRBS REPLY TEST - PASSED **
F1 TO F2 SPACING A:20.30 µS  C:20.30 µS
F1 PULSE WIDTH   A: 0.45 µS  C: 0.45 µS
F2 PULSE WIDTH   A: 0.45 µS  C: 0.45 µS
CODE=  7777      ALT= 10,700 FT [6140]
          Press RUN to start
```

```
    ** ATCRBS REPLY TEST - FAILED **
F1 TO F2 SPACING→A:22.00 µS  C:20.30 µS
F1 PULSE WIDTH   A: 0.45 µS  C: 0.45 µS
F2 PULSE WIDTH   A: 0.45 µS  C: 0.45 µS
CODE=  7777      ALT= 10,700 FT [6140]
          Press RUN to start
```

Sample ATCRBS Reply Test Screens
Figure 16

4. SLS Level (Refer to 1-2-4, Figure 17.)

Interrogates with ATCRBS Modes A and C interrogations including the P_2 SLS pulse, verifying valid replies are received when P_2 level is set at -9 dB and no reply is received when P_2 level is set at 0 dB. Results are indicated on DISPLAY (14).

NOTE: Because interrogation with SLS at -9 dB is sent at MTL + 12 dB, SLS Test must be run within 95 feet (28.96 meters) of UUT Antenna being tested.

```
** SLS LEVEL TEST - PASSED **

-9 dB: REPLY
 0 dB: NO REPLY

Press RUN to start
```

```
** SLS LEVEL TEST - FAILED **

 -9 dB: REPLY
→ 0 dB: REPLY

Press RUN to start
```

```
** SLS LEVEL TEST - FAILED **

→-9 dB: NO REPLY
  0 dB: NO REPLY

Press RUN to start
```

Sample SLS Level Test Screens
Figure 17

5. ATCRBS Only All-Call (Refer to 1-2-4 Figure 18.)

   Interrogates with an ATCRBS only All-Call and verifies no reply is received from Mode S transponders. DISPLAY (14) indicates results.

```
** ATC ONLY ALL-CALL TEST - PASSED **

PASSED TEST

Press RUN to start
```

```
** ATC ONLY ALL-CALL TEST - FAILED **

MODE S XPDR REPLIED WITH ATCRBS

Press RUN to start
```

Sample ATCRBS Only All-Call Test Screens
Figure 18

```
** ATC ONLY ALL-CALL TEST - NO REPLY**


          Press RUN to start
```

```
** ATC ONLY ALL-CALL TEST - FAILED **

   MODE S XPDR REPLIED WITH MODE S

          Press RUN to start
```

Sample ATCRBS Only All-Call Test Screens
Figure 18 (Cont)

6. Mode S All-Call (Refer to 1-2-4, Figure 19.)

   Interrogates with the ATCRBS (Mode A)/Mode S All-Call and displays the DF11 reply address. This address is then sent in a UF4 interrogation. The DF4 reply address is indicated on DISPLAY (14) and compared with the one used. Test fails if Mode S reply is not received or address is inconsistent.

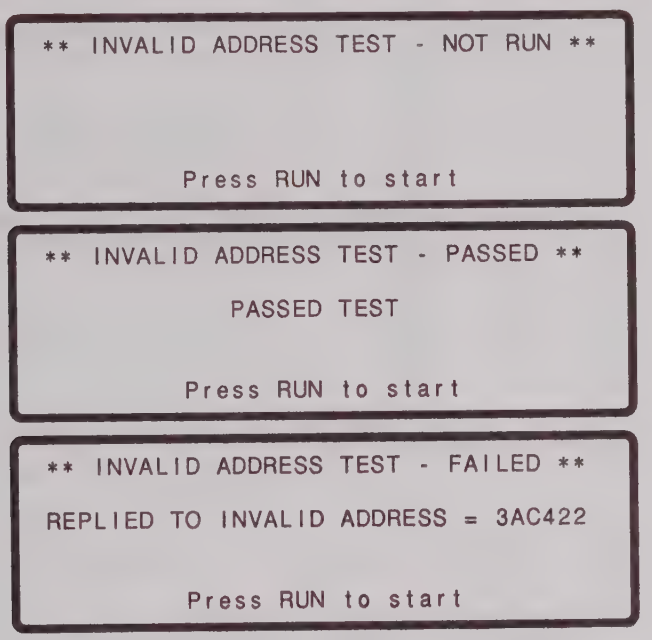
```
** MODE S ALL-CALL TEST - PASSED **
ALL-CALL ADDRESS = 3AC421 [16542041]
TAIL NUMBER      = N12345


          Press RUN to start
```

```
** MODE S ALL-CALL TEST - FAILED **
ALL CALL ADDRESS = 3BD532 [16752462]
TAIL NUMBER      = N12345
DF4 REPLY ADDRESS= 3AC421

          Press RUN to start
```

Sample Mode S All-Call Test Screens
Figure 19

7. Invalid Address (Refer to 1-2-4, Figure 20.)

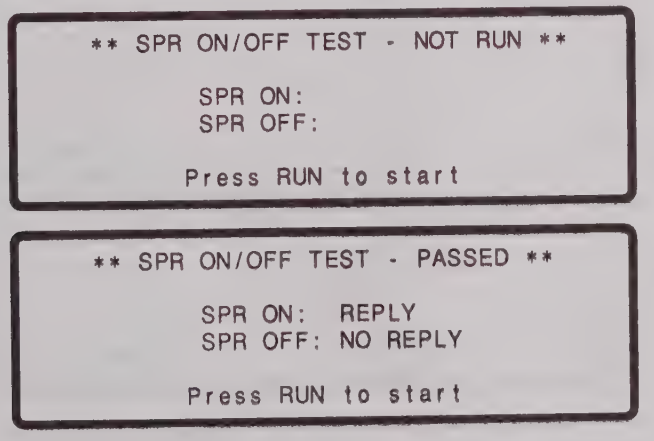
   Transmits Mode S interrogations using addresses different from the address determined by the Mode S All-Call (UF11) and verifies no reply is received. Results are indicated on DISPLAY (14).


** INVALID ADDRESS TEST - NOT RUN **
Press RUN to start
** INVALID ADDRESS TEST - PASSED **
PASSED TEST
Press RUN to start
** INVALID ADDRESS TEST - FAILED **
REPLIED TO INVALID ADDRESS = 3AC422
Press RUN to start

Sample Invalid Address Test Screens
Figure 20

8 SPR On/Off (Refer to 1-2-4, Figure 21.)

Interrogates with a Mode S interrogation with SPR On and indicates if reply is received. The same interrogation is sent again with SPR Off and test verifies no reply is received. Results are indicated on DISPLAY (14).


** SPR ON/OFF TEST - NOT RUN **
SPR ON:
SPR OFF:
Press RUN to start
** SPR ON/OFF TEST - PASSED **
SPR ON: REPLY
SPR OFF: NO REPLY
Press RUN to start

Sample SPR On/Off Test Screens
Figure 21

```
** SPR ON/OFF TEST - FAILED **

   SPR ON:  REPLY
→ SPR OFF: REPLY

  Press RUN to start
```

```
** SPR ON/OFF TEST - FAILED **

→ SPR ON:  NO REPLY
  SPR OFF: NO REPLY

  Press RUN to start
```

Sample SPR On/Off Test Screens
Figure 21 (Cont)

9. Mode S UF0 (Refer to 1-2-4, Figure 22.)

   Interrogates with UF0 verifying a reply is received having correct altitude, same address and correct format. Altitude reported in DF0 is compared with altitude reported during Mode Test in valid ATCRBS Mode C reply. Address is compared with address reported during Mode Test in DF11 reply. Downlink Format Fields are indicated on DISPLAY (14). If test fails because of incorrect altitude, Mode C altitude is displayed. If test fails because of wrong address, DF11 address is displayed. UF0 AQ bit is "1" for requesting airspeed information in DF0 RI field.

   NOTE: AC field blanks out if invalid data is received for that field.

```
** MODE S UF0 TEST - NO REPLY **

DF    VS=     RI=     AC=
ADDRESS=

      **** TEST RUNNING  ****
```

```
** MODE S UF0 TEST - PASSED **

DF 0  VS=1    RI=C    AC= 10,700 FT
ADDRESS=3AC421

      Press RUN to start
```

Sample Mode S UF0 Test Screens
Figure 22

```
** MODE S UF0 TEST - FAILED **

DF 0  VS=1    RI=C   →AC= 10,800 FT
ADDRESS=3AC421
MODE C ALT = 10,700 FT
        Press RUN to start
```

```
** MODE S UF0 TEST - FAILED **

DF 0  VS=1    RI=C    AC= 10,700 FT
→ADDRESS=3BD432
DF11 ADDR=3AC421
        Press RUN to start
```

```
** MODE S UF0 TEST - FAILED **

→DF 4  VS=1    RI=C    AC= 10,700 FT
ADDRESS=3AC421

        Press RUN to start
```

Sample Mode S UF0 Test Screens
Figure 22 (Cont)

10. Mode S UF4 (Refer to 1-2-4, Figure 23.)

Interrogates with UF4 verifying a reply is received having correct altitude, same address and correct format. Altitude reported in DF4 (Surveillance, altitude reply) is compared with altitude reported during Mode Test in valid ATCRBS Mode C reply. Address is compared with address reported during Mode Test in DF11 reply. Downlink Format Fields are indicated on DISPLAY (14). If test fails because of incorrect altitude, Mode C altitude is displayed. If test fails because of wrong address, DF11 address is displayed.

NOTE: AC field blanks out if invalid data is received for that field.

```
** MODE S UF4 TEST - NO REPLY **

DF    FS=   DR=    UM=     AC=
ADDRESS=

        *** TEST RUNNING **'
```

Sample Mode S UF4 Test Screens
Figure 23

```
** MODE S UF4 TEST - PASSED **

DF 4 FS=1 DR=00 UM=00  AC= 10,700 FT
ADDRESS=3AC421

        Press RUN to start
```

```
** MODE S UF4 TEST - FAILED **

DF 4 FS=1 DR=00 UM=00 →AC= 10,800 FT
ADDRESS=3AC421
MODE C ALT = 10,700 FT
        Press RUN to start
```

```
** MODE S UF4 TEST - FAILED **

 DF 4 FS=1 DR=00 UM=00  AC= 10,700 FT
→ADDRESS=3AB352
 DF11 ADDR=3AC421
        Press RUN to start
```

```
** MODE S UF4 TEST - FAILED **

→DF 0 FS=1 DR=00 UM=10  AC= 10,700 FT
 ADDRESS=3AC421

        Press RUN to start
```

Sample Mode S UF4 Test Screens
Figure 23 (Cont)

11. Mode S UF5 (Refer to 1-2-4, Figure 24.)

    Interrogates with UF5 verifying a reply is received having correct ID, same address and correct format. ID code reported in DF5 (Surveillance, Identity reply) is compared with ID code reported during Mode Test in valid ATCRBS Mode A reply. Address is compared with address reported during Mode Test in DF11 reply. Downlink Format Fields are indicated on DISPLAY (14). If test fails because of incorrect ID code, Mode A, ID code is displayed. If test fails because of wrong address, DF11 address is displayed.

```
** MODE S UF5 TEST - NO REPLY **

DF   FS=   DR=    UM=     ID=
ADDRESS=

        *** TEST RUNNING ***
```

```
** MODE S UF5 TEST - PASSED **

DF 5 FS=1 DR=00 UM=00   ID=7777
ADDRESS=3AC421

          Press RUN to start
```

```
** MODE S UF5 TEST - FAILED **

DF 5 FS=1 DR=00 UM=00 →ID=7377
ADDRESS=3AC421
MODE A CODE=  7777
          Press RUN to start
```

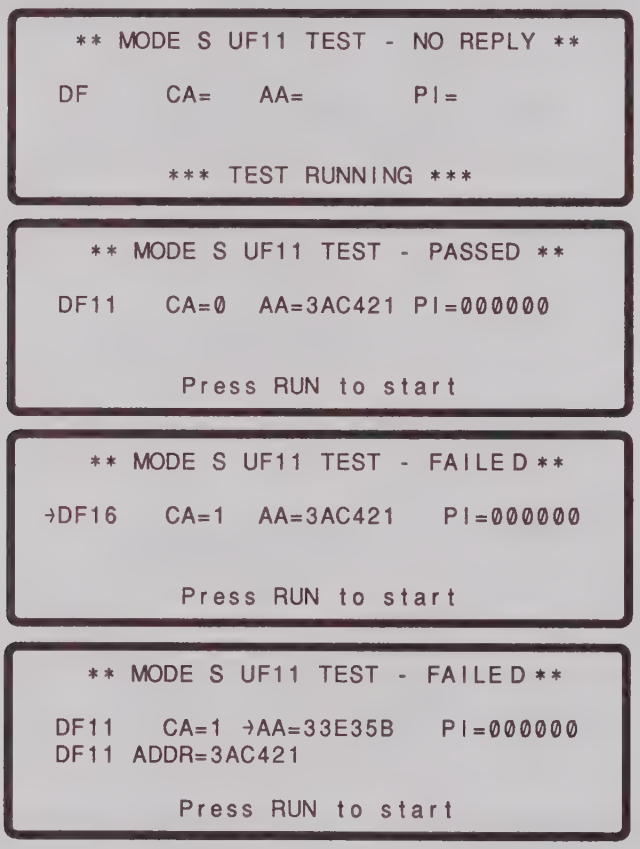
```
** MODE S UF5 TEST - FAILED **

 DF 5 FS=1 DR=00 UM=00   ID=7777
→ADDRESS=3BDE31
 DF11 ADDR=3AC421
          Press RUN to start
```

```
** MODE S UF5 TEST - FAILED **

→DF 0 FS=3 DR=12 UM=14   ID=3180
 ADDRESS=3AC421

          Press RUN to start
```

Sample Mode S UF5 Test Screens
Figure 25

12. Mode S UF11 (Refer to 1-2-4, Figure 25.)

Interrogates with UF11 verifying a reply is received having same address and correct format. Address is compared with address reported during Mode Test. Downlink Format Fields are indicated on DISPLAY (14). If test fails because of incorrect AA, Mode Test address is displayed.


** MODE S UF11 TEST - NO REPLY **
DF CA= AA= PI=
*** TEST RUNNING ***
** MODE S UF11 TEST - PASSED **
DF11 CA=0 AA=3AC421 PI=000000
Press RUN to start
** MODE S UF11 TEST - FAILED **
→DF16 CA=1 AA=3AC421 PI=000000
Press RUN to start
** MODE S UF11 TEST - FAILED **
DF11 CA=1 →AA=33E35B PI=000000
DF11 ADDR=3AC421
Press RUN to start

Sample Mode S UF11 Test Screens
Figure 24

13. Mode S UF16 (Refer to 1-2-4, Figure 26.)

Interrogates with UF16 verifying reply, if received, has correct altitude, same address and correct format. Altitude reported in DF16 is compared with altitude reported during Mode Test in valid ATCRBS Mode C reply. Address is compared with address reported during Mode Test in DF11 reply. Downlink Format Fields are indicated on DISPLAY (14). If test fails because of incorrect AC, Mode C altitude is displayed. If test fails because of wrong address, DF11 address is displayed. UF16 AQ bit is "0" for requesting TCAS capability information in DF16 RI field.

NOTE: AC field blanks out if invalid data is received for that field.

```
** MODE S UF16 TEST - PASSED **

DF16  VS=0      RI=0    AC= 10,700 FT
MV=00000000000000       ADDRESS=3AC421

        Press RUN to start
```

```
** MODE S UF16 TEST - FAILED **

DF16  VS=0      RI=0   →AC= 10,800 FT
MV=00000000000000       ADDRESS=3AC421
MODE C ALT= 10,700 FT
        Press RUN to start
```

```
** MODE S UF16 TEST - FAILED **

DF16    VS=0    RI=0    AC= 10,700 FT
MV=00000000000000      →ADDRESS=543212
DF11 ADDR=3AC421
        Press RUN to start
```

```
** MODE S UF16 TEST - FAILED **

→DF21  VS=0     RI=0    AC= 10,700 FT
 MV=00000000000000      ADDRESS=3AC421

        Press RUN to start
```

```
** MODE S UF16 TEST - NO REPLY **

DF      VS=     RI=     AC=
MV=                     ADDRESS=

        Press RUN to start
```

Sample Mode S UF16 Test Screens
Figure 26

14. Mode S UF20 (Refer to 1-2-4, Figure 27.)

Interrogates with UF20 verifying reply, if received, has correct altitude, same address and correct format. Altitude reported in DF20 (Comm B, altitude reply) is compared with altitude reported during Mode Test in DF11 reply. Downlink Format Fields are indicated on DISPLAY (14). If test fails because of incorrect AC, Mode C altitude is displayed. If test fails because of wrong address, DF11 address is displayed.

NOTE: AC field blanks out if invalid data is received for that field.

```
   ** MODE S UF20 TEST - PASSED **

DF20 FS=0  DR=00 UM=00 AC= 10,700 FT
MB=00000000000000      ADDRESS=3AC421

          Press RUN to start
```

```
   ** MODE S UF20 TEST - FAILED **

DF20 FS=0  DR=00 UM=00→AC= 10,800 FT
MB=00000000000000      ADDRESS=3AC421
MODE C ALT= 10,700 FT
          Press RUN to start
```

```
   ** MODE S UF20 TEST - FAILED **

DF20 FS=0  DR=00 UM=00 AC= 10,700 FT
MB=00000000000000     →ADDRESS=3BD422
DF11 ADDR=3AC421
          Press RUN to start
```

```
   ** MODE S UF20 TEST - FAILED **

→DF21 FS=0  DR=00 UM=00 AC= 10,700 FT
 MB=00000000000000      ADDRESS=3AC421

          Press RUN to start
```

```
  ** MODE S UF20 TEST - NO REPLY **

DF    FS=    DR=    UM=    AC=
MB=                        ADDRESS=

          Press RUN to start
```

Sample Mode S UF20 Test Screens
Figure 27

15. Mode S UF21 (Refer to 1-2-4, Figure 28.)

Interrogates with UF21 verifying reply, if received, has correct ID, same address and correct format. ID code reported in DF21 (Comm B, identity reply) is compared with ID code reported during Mode Test in valid ATCRBS Mode A reply. Address is compared with address reported during Mode Test in DF11 reply. Downlink Format Fields are indicated on DISPLAY (14). If test fails because of incorrect ID code, Mode A ID code is displayed. If test fails because of wrong address, DF11 address is displayed.

```
** MODE S UF21 TEST - PASSED **

DF21 FS=0  DR=00 UM=00 ID=7777
MB=00000000000000      ADDRESS=3AC421

        Press RUN to start
```

```
** MODE S UF21 TEST - FAILED **

DF21 FS=0  DR=00 UM=00→ID=7377
MB=00000000000000      ADDRESS=3AC421
MODE A CODE=  7777
      **** TEST RUNNING ****
```

```
** MODE S UF21 TEST - FAILED **

DF21 FS=0  DR=00 UM=00 ID=7777
MB=00000000000000     →ADDRESS=3BD422
DF11 ADDR=3AC421
        Press RUN to start
```

```
** MODE S UF21 TEST - FAILED **

→DF16 FS=0  DR=00 UM=00 ID=3247
MB=00000000000000      ADDRESS=3AC421

        Press RUN to start
```

```
** MODE S UF21 TEST - NO REPLY **

DF    FS=   DR=   UM=   ID=
MB=                     ADDRESS=

        Press RUN to start
```

Sample Mode S UF21 Test Screens
Figure 28

16. Squitter (Refer to 1-2-4, Figure 29.)

Verifies time period between UUT squitters is 0.8 to 2.4 seconds. Measured time between UUT squitters is displayed along with squitter address (hexadecimal and octal) and tail number.

```
    ** SQUITTER TEST - PASSED **
PERIOD = 1.00 SECONDS
TAIL NUMBER = N12345
SQUITTER ADDRESS=3AC421 [16542041]

          Press RUN to start
```

```
    ** SQUITTER TEST - FAILED **
→PERIOD = 2.64 SECONDS
 TAIL NUMBER = N12345
 SQUITTER ADDRESS=3AC421 [16542041]

          Press RUN to start
```

```
    ** SQUITTER TEST - NOT RUN **
PERIOD =       SECONDS
TAIL NUMBER =
SQUITTER ADDRESS=          [          ]

          Press RUN to start
```

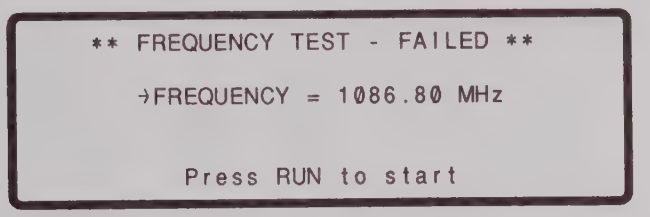
Sample Squitter Test Screens
Figure 29

17. Frequency (Refer to 1-2-4, Figure 30.)

Verifies UUT frequency is 1090 MHz (±3 MHz). UUT frequency is displayed.

```
** FREQUENCY TEST - PASSED **

    FREQUENCY = 1092.30 MHz


       Press RUN to start
```

Sample Frequency Test Screens
Figure 30

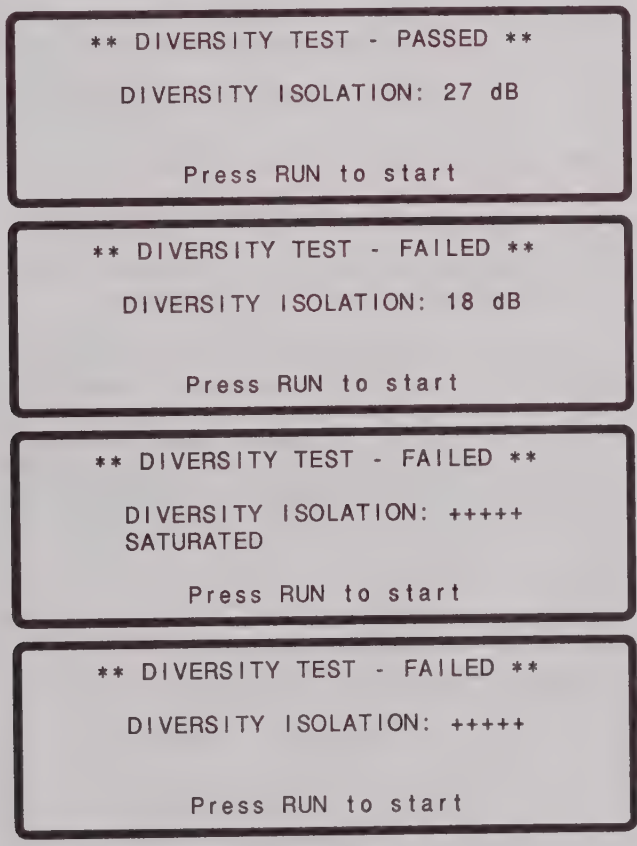


Sample Frequency Test Screens
Figure 30 (Cont)

18. Diversity (Refer to 1-2-4, Figure 31.)

Verifies UUT diversity isolation (difference between "on" antenna squitters and "off" antenna squitters) is ≥20 dB. ATC-601 displays diversity isolation in dB. Test only runs if set in Setup#3 Menu.

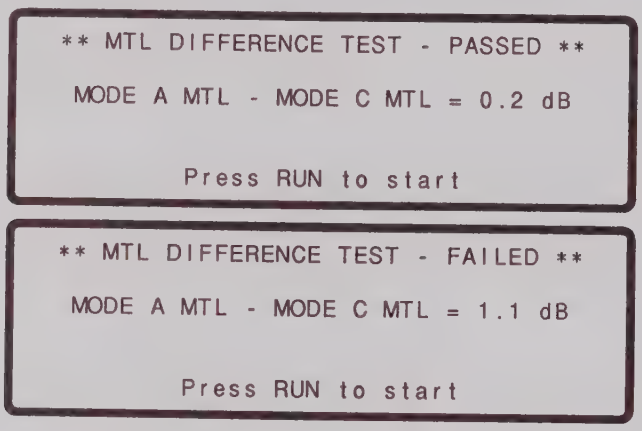
NOTE: To insure ≥20 dB dynamic range, test must be run within 50 feet (15.24 meters) of UUT Antenna being tested.


** DIVERSITY TEST - PASSED **
DIVERSITY ISOLATION: 27 dB
Press RUN to start
** DIVERSITY TEST - FAILED **
DIVERSITY ISOLATION: 18 dB
Press RUN to start
** DIVERSITY TEST - FAILED **
DIVERSITY ISOLATION: +++++
SATURATED
Press RUN to start
** DIVERSITY TEST - FAILED **
DIVERSITY ISOLATION: +++++
Press RUN to start

Sample Diversity Test Screens
Figure 31

19. MTL Difference (Refer to 1-2-4, Figure 28.)

Verifies Receiver Sensitivity or MTL to Mode A interrogations does not differ more than 1 dB from MTL to Mode C interrogations. The MTL difference, based on the average of 100 Mode A and 100 Mode C interrogations, is displayed.


** MTL DIFFERENCE TEST - PASSED **
MODE A MTL - MODE C MTL = 0.2 dB
Press RUN to start
** MTL DIFFERENCE TEST - FAILED **
MODE A MTL - MODE C MTL = 1.1 dB
Press RUN to start

Sample MTL Difference Test Screens
Figure 32

E. Power Test

(1) General

The function of the Power Test is to accurately determine the ERP and MTL of the transponder, whether or not a direct connection with UUT is used. Two values for each measurement are provided on the DISPLAY (14). INSTANT values are obtained from the average power readings of the replies received to 100 interrogations. This value is updated every 100 interrogations. The TOP AVG and BOT AVG values are obtained from the average power readings of all replies received during the Power Test sequence.

POWER Test verifies:

- 48.5 dBm <UUT ERP <57.0 dBm
- UUT MTL =-73.0 dBm (±4.0 dB)

(2) Procedure (Refer to 1-2-4, Figures 33, 34 and 35.)

NOTE: Power Test must be run at the Distance/Range established in Setup#1 Menu procedure. Refer to 1-2-4, Figures 8, 34 and 35.

STEP	PROCEDURE

1. Press PWR TEST Key (12) to enter Power Test screen. (ATC-601 displays results from last Power Test in units selected in Setup#3 Menu.)
2. Select UUT Antenna to be tested, top or bottom, with SELECT Keys (10).

```
                ** POWER TEST **
                ERP(WATTS)   MTL(dBm)   STATUS
·TOP AVG =         156         -73.4    PASSED
 BOT AVG =         135         -74.3    PASSED
 INSTANT =         146         -73.4
          Press RUN to start
```

```
                ** POWER TEST **
                ERP(dBm  )   MTL(dBm)   STATUS
 TOP AVG =         53.0        -73.4    PASSED
·BOT AVG = →       47.8        -75.0    FAILED
 INSTANT =         47.8        -75.0
          Press RUN to start
```

USING TEST SET ANTENNA

```
      ** POWER TEST - TOP ANTENNA **

ANTENNA      ERP(WATTS)   MTL(dBm)   STATUS
   Top          156         -73.4    PASSED

          Press RUN to start
```

```
      ** POWER TEST - BOTTOM ANTENNA **

ANTENNA      ERP(dBm  )   MTL(dBm)   STATUS
 Bottom         53.0        -73.4    PASSED

          Press RUN to start
```

DIRECT CONNECTION

Sample Power Test Screens
Figure 33

STEP PROCEDURE

3. Connect UUT to RF I/O Connector (15) for direct connection or connect a Test Set Antenna (Flat Antenna is most accurate) to ANTENNA Connector (16).

   NOTE: If direct connection is not used, UUT Antenna not being tested must be shielded with Antenna Shield (refer to Appendix D) or disconnected and terminated with 50 Ω load.

   NOTE: If direct connection is used, ATC-601 ANTENNA Connector (16) must be terminated with 50 Ω load (Connector Cover).

4. Face Test Set Antenna towards UUT Antenna. Press RUN/STOP Key (9) or ANTENNA PUSH BUTTON Switch (21) to initiate Power Test. If Direct Connection is used, go to Step 6.

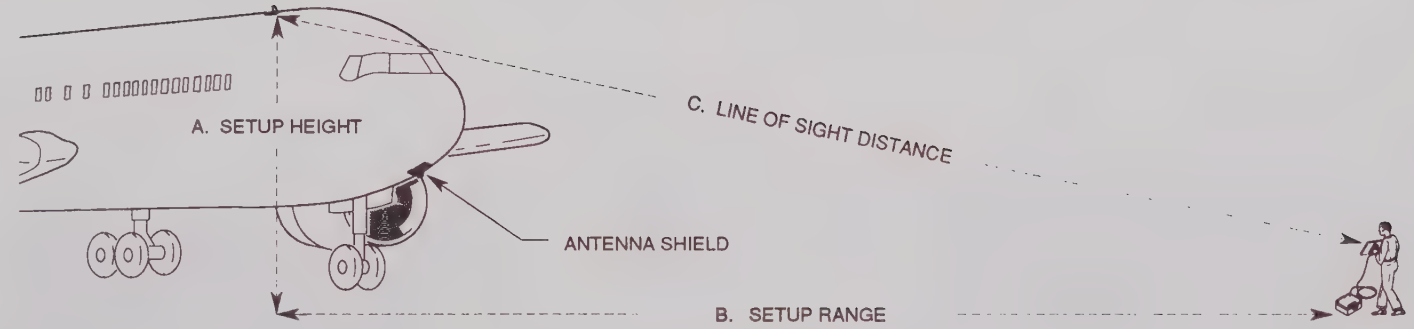
   NOTE: Test Set displays accurate power readings when Flat Antenna is facing UUT at Setup#1 Menu Range (distance) according to 1-2-4, Figures 34 and 35. If more accuracy is required, Step 5 is recommended to further reduce errors caused by multipath from the ramp.

5. Starting from ground level, move Flat Antenna upward 6 feet (1.8 meters) at <1 ft/sec (0.3 m/sec).

   NOTE: Do not move towards or away from UUT or Range is inconsistent. Do not rotate Flat Antenna or power levels are reduced.

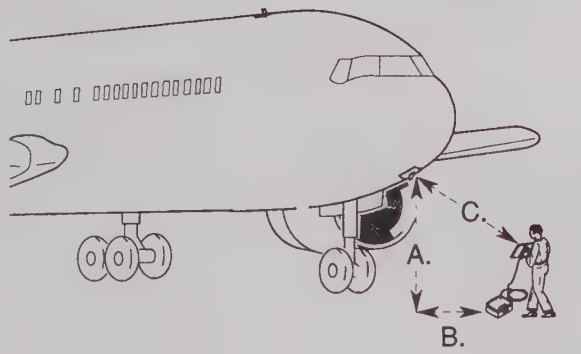
6. Press RUN/STOP Key (9) or ANTENNA PUSH BUTTON Switch (21) to terminate Power Test.

Suggested Layout to Reduce Multipath Errors
Figure 34



TESTING TOP ANTENNA

Ramp Testing
Figure 35



WHEN SHIELDING OR TERMINATING TOP ANTENNA IS NOT PRACTICAL, USE SETUP POSITION THAT HAS AIRCRAFT BLOCKING LINE OF SIGHT TO TOP ANTENNA.

TESTING BOTTOM ANTENNA

APPENDIX B - ABBREVIATIONS

A

AA	Announced Address
AC	Altitude Code
AC/ac	Alternating Current
ACAS	Airborne Collision Avoidance System
ACS	Comm-A Capability Subfield
A/D	Analog to Digital
ADC	Analog to Digital Convertor
AIS	Comm-A Capability Subfield
ALT	Altitude
AP	Address Parity
AQ	Special Acquisition
ATC	Air Traffic Control
ATC	ATCRBS (screen abbreviation)
ATCRBS	Air Traffic Control Radar Beacon System
ATE	Automatic Test Equipment
ATTEN	Attenuation
AUTO	Automatic
AVG	Average

B

BAT	Battery
BCS	Comm-B Capability Subfield
BDS	B-Definition Subfield
BIT	Built In Test
BOT	Bottom
bps	Bits per Second
BR	Bridge Rectifier
BT	Battery

C

C	Centigrade
CA	Transponder Capability
CAS	Column Address Strobe
CFS	Continuation Subfield
CH	Channel
CHC	Cancel Horizontal Resolution Advisory Complement
CLI	Coordination Lock Indicator
CMOS	Complementary Metal-Oxide Semiconductor
COMM	Communication
Cont	Continued
CPU	Central Processing Unit
CR	Diode
CrLf	Carriage Return and Line Feed
CTS	Clear to Send
CVC	Cancel Vertical Resolution Advisory Complement
CW	Continuous Wave

D

D/A	Digital to Analog
DAC	Digital to Analog Convertor
dB	Decibel
dBi	Decibels above isotropic
dBm	Decibels above one milliwatt
dB W/m^2	Decibels above one watt per square meter
DCD	Data Carrier Detect
DCXO	Digitally Compensated Crystal Oscillator
DF	Downlink Format
DI	Designator Identification
Div	Division
DMA	Direct Memory Access
DMM	Digital Multimeter
DPR	Dual Port RAM
DPSK	Differential Phase Shift Key
DR	Downlink Request
DSP	Digital Signal Processor
DSR	Data Set Ready
DTR	Data Terminal Ready

E

ECS	Extended Capability Subfield
ELM	Extended Length Message
ERP	Effective Radiated Power
ESB	Encoded Sense Bits
Ext	External

F

FCC	Federal Communications Commission
FET	Field Effect Transistor
FIFO	First In First Out
FPM	Feet Per Minute
FREQ	Frequency
FS	Flight Status
Ft	Feet

G

GEN	Generator
GND	Ground
GPIB	General Purpose Interface Bus

H

h	Hexadecimal
HET	Heterodyne
hr	Hour
HRC	Horizontal Resolution Advisory Complement
Hz	Hertz

I

ID	Identification (4906 Code)
IDS	Identifier Designators Subfield
IF	Intermediate Frequency
IFR	IFR Systems, Inc
II	Interrogator Identification
IIS	Interrogator Identification Subfield
INTERR	Interrogation
I/O	Input/Output
ITM	Intermode

K

KE	ELM Control
kHz	Kilohertz (10^3)
km	Kilometer (10^3)
kts	Knots (Velocity)

L

LC	Inductor-Capacitor
LCA	Logic Cell Array
LCD	Liquid Crystal Display
LCK	Coordination Lock Subfield
LCS	Lower Chip Select
LED	Light Emitting Diode
LO	Local Oscillation
LOS	Lockout Subfield
LSD	Least Significant Digit

M

m	meters
MA	Comm-A Message
Max	Maximum
MB	Comm-B Message
MBS	Multisite Comm-B Subfield
MC	Comm-C Message
MCS	Mid-Range Chip Select
MD	Comm-D Message
MEAS	Measuring
MES	Multisite ELM Subfield
MHz	Megahertz (10^6)
µs	Microsecond
MID	Mode S Address
MPU	Microprocessing Unit
ms	Millisecond (10^{-3})
MSD	Most Significant Digit
MTB	Multiple Threat Bit
MTL	Minimum Triggering Level
MU	Comm-U Message
MV	Comm-V Message

N

N/A	Not Applicable
NC	C-Segment Number
ND	D-Segment Number
nmi	Nautical Miles
No	Number
ns	Nanosecond (10^{-9})

O

O'SCOPE	Oscilloscope

P

PC	Personal Computer
PC	Printed Circuit
PC	Protocol
PCBD	Printed Circuit Board
PCS	Peripheral Chip Select
PI	Parity/Interrogator Identity
PPG	Pulse Power Gate
PPM	Pulse Position Modulation
PR	Reply Probability
PRF	Pulse Repetition Frequency
PWM	Pulse Width Modulation
PWR	Power

R

RAM	Random Access Memory
RAC	Resolution Advisory Complement
RAS	Row Address Strobe
RC	Reply Control
RC	Resistor-Capacitor
RCVR	Receiver
Ref	Reference
RF	Radio Frequency
RI	Reply Information, Air-to-Air
RL	Reply Length
RMS	Root Mean Square
ROM	Read Only Memory
RR	Reply Request
RRS	Reply Request Subfield
RSS	Reservation Status Subfield
RTCA	Radio Technical Commission for Aeronautics
RTS	Request to Send
RX	Receive
RXD	Receive Data

S

SD	Special Designator
sec	Second(s)
SL	Sensitivity Level
SLS	Side Lobe Suppression
SMENU	Sequence Menu
SPI	Special Identifier Pulse
SPR	Synchronous Phase Reversal
SRQ	Service Request
SRS	Segment Request Subfield
SSR	Secondary Surveillance Radar
SYNC	Synchronization

T

T	Transformer
TAS	Transmission Acknowledgement Subfield
TCAS	Traffic Alert and Collision Avoidance System
TMS	Tactical Message Subfield
Trig	Trigger
TTL	Transistor Transistor Logic
TX	Transmit
TXD	Transmit Data

U

UART	Universal Asynchronous Receiver-Transmitter
UCS	Upper Chip Select
UDS	U-Definition Subfield
UF	Uplink Format
UM	Utility Message
UUT	Unit Under Test

V

V	Volts
VAC	Volts Alternating Current
VCO	Voltage Controlled Oscillator
Vdc	Volts Direct Current
VDS	V-Definition Subfield
VERS	Version
VRAM	Video Random Access Memory
VRC	Vertical Resolution Advisory Complement
Vrms	Volts Root Mean Square
VS	Vertical Status
VSWR	Voltage Standing Wave Ratio

W

W	Watts

X

XMTR	Transmitter
XOR	Exclusive OR
XPDR	Transponder

APPENDIX C - SIGNAL FORMATS

1. Operating Goals

Mode S is a combined secondary surveillance radar and potential ground-air-ground data link system capable of providing aircraft surveillance and communications necessary to support automated ATC in dense traffic environments. Mode S is capable of common-channel interoperation with the ATC beacon system and may be implemented over an extended ATCRBS-to-Mode S transition period. Supporting ATC automation, Mode S provides the reliable communications necessary for data link services.

2. Mode S Message Content

A. Address/Parity (Field AP)

All discrete Mode S interrogations (56-bit or 112-bit) and replies (except the All-Call reply) contain the 24-bit discrete address of the Mode S transponder upon which 24 error-detecting parity check bits are overlaid. In the All-Call reply, the 24 parity check bits are overlaid on the address of the Mode S interrogator and the discrete address of the transponder is included in the text of the reply.

B. Surveillance

The primary function of Mode S is surveillance. The Mode S transponder performs this function using "short" (56-bit) transmissions in both directions. In these transmissions, the aircraft reports altitude (DF04) or ATCRBS 4096 code as well as flight status (airborne, on ground, alert, Special Position Identification [SPI], etc.).

C. Data Link Communications

The discrete addressing and digital encoding allow Mode S transmissions to be used as digital data links. The interrogation and reply formats of the Mode S system contain sufficient coding space to transmit data. Most Mode S data link transmissions are handled as one 56-bit message included as part of "long" 112-bit interrogations or replies. The transmissions include the message in addition to surveillance data, and is generally used in place of a surveillance interrogation and/or reply.

An efficient transmission of longer messages is accomplished by the extended length message (ELM) capability (UF24 and DF24). Using this capability, a sequence of up to sixteen 80-bit message segments (each with a 112-bit transmission) is transmitted, either ground-to-air or air-to-ground and is acknowledged with a single reply/interrogation. ELMs do not contain surveillance data and thus cannot substitute for a surveillance interrogation-reply cycle.

3. Signal Formats

Signal formats for Uplink and Downlink messages are outlined in Chapter 2, RTCA DO-181 and Chapter 2, Volume I of RTCA DO-185. Tables 1, 2, 3 and 4 contain the signal formats and definitions. Data is expressed in decimal. Refer to Table 5 for conversion to hexadecimal, octal or binary. Table 6 shows the ATC-601 fixed formats for Mode S using Front Panel operation.

NOTE: TCAS operates in Mode S and many signals pertain only to TCAS.

FORMAT NO.	UF	
0	(0 0000)	--3--(RL:1)—4—(AQ:1)——18——(AP:24) .....Short Air-Air Surveillance
1	(0 0001)	————————27 or 83————————(AP:24)
2	(0 0010)	————————27 or 83————————(AP:24)
3	(0 0011)	————————27 or 83————————(AP:24)
4	(0 0100)	(PC:3) (RR:5) (DI:3) (SD:16) (AP:24) ... Surveillance, Altitude Request
5	(0 0101)	(PC:3) (RR:5) (DI:3) (SD:16) (AP-24) ....Surveillance, Identity Request
6	(0 0110)	————————27 or 83————————(AP:24)
7	(0 0111)	————————27 or 83————————(AP:24)
8	(0 1000)	————————27 or 83————————(AP:24)
9	(0 1001)	————————27 or 83————————(AP:24)
10	(0 1010)	————————27 or 83————————(AP:24)
11	(0 1011)	(PR:4) (II:4)————-19————-(AP:24) ..... Mode S Only All-Call
12	(0 1100)	————————27 or 83————————(AP:24)
13	(0 1101)	————————27 or 83————————(AP:24)
14	(0 1110)	————————27 or 83————————(AP:24)
15	(0 1111)	————————27 or 83————————(AP:24)
16	(1 0000)	-3-(RL:1)-4-(AQ:1)—18—(MU:56) (AP:24) ..... Long Air-Air Surveillance
17	(1 0001)	————————27 or 83————————(AP:24)
18	(1 0010)	————————27 or 83————————(AP:24)
19	(1 0011)	————————27 or 83————————(AP:24)
20	(1 0100)	(PC:3) (RR:5) (DI:3) (SD:16) (MA:56) (AP:24) ..Comm-A, Altitude Request
21	(1 0101)	(PC:3) (RR:5) (DI:3) (SD:16) (MA:56) (AP:24) ..Comm-A, Identity Request
22	(1 0110)	————————27 or 83————————(AP:24)
23	(1 0111)	————————27 or 83————————(AP:24)
24	(1 1xxx)	(RC:2) (NC:4) (MC:80) (AP:24) ..... Comm-C (ELM)

NOTE: (XX:M) denotes a field designated "XX" which is assigned M bits.

NOTE: —N— denotes free coding space with N available bits. These are coded as ZEROs for transmission.

NOTE: For Uplink Formats (UF) 0 through 23, the format number corresponds to the binary code in the first 5 bits of the interrogation. Format number 24 is arbitrarily defined as the format beginning with "11" in the first two bit positions. The following three bits (xxx) vary according to the interrogation content.

NOTE: All formats are shown for completeness, although a number of them are unused.

Overview of Mode S Interrogation Formats
Table 1

FORMAT NO.	DF	
0	(0 0000)	(VS:1)-2-(SL:3)-2-(RI:4)-2-(AC:13) (AP:24) ..... Short Air-Air Surveillance
1	(0 0001)	——————27 or 83——————-(P:24)
2	(0 0010)	——————27 or 83——————-(P:24)
3	(0 0011)	——————27 or 83——————-(P:24)
4	(0 0100)	(FS:3) (DR:5) (UM:6) (AC:13) (AP:24) ..... Surveillance, Altitude Reply
5	(0 0101)	(FS:3) (DR:5) (UM:6) (ID:13) (AP-24) ..... Surveillance, Identity Reply
6	(0 0110)	——————27 or 83——————-(P:24)
7	(0 0111)	——————27 or 83——————-(P:24)
8	(0 1000)	——————27 or 83——————-(P:24)
9	(0 1001)	——————27 or 83——————-(P:24)
10	(0 1010)	——————27 or 83——————-(P:24)
11	(0 1011)	(CA:3) (AA:24) (PI:24) ..... All-Call Reply/Squitter
12	(0 1100)	——————27 or 83——————-(P:24)
13	(0 1101)	——————27 or 83——————-(P:24)
14	(0 1110)	——————27 or 83——————-(P:24)
15	(0 1111)	——————27 or 83——————-(P:24)
16	(1 0000)	(VS:1)-2-(SL:3)-2-(RI:4)-2-(AC:13)(MV:56)(AP:24) .Long Air-Air Surveillance
17	(1 0001)	——————27 or 83——————-(P:24)
18	(1 0010)	——————27 or 83——————-(P:24)
19	(1 0011)	——————27 or 83——————-(P:24)
20	(1 0100)	(FS:3) (DR:5) (UM:6) (AC:13) (MB:56) (AP:24) ....Comm-B, Altitude Reply
21	(1 0101)	(FS:3) (DR:5) (UM:6) (ID:13) (MB:56) (AP:24) .....Comm-B, Identity Reply
22	(1 0110)	——————27 or 83——————-(P:24)
23	(1 0111)	——————27 or 83——————-(P:24)
24	(1 1xxx)	(KE:1) (ND:4) (MD:80) (AP:24) .....Comm-D (ELM)

NOTE: (XX:M) denotes a field designated "XX" which is assigned M bits.

NOTE: (P:24) denotes a 24-bit field reserved for parity information.

NOTE: —N— denotes free coding space with N available bits. These are coded as ZEROs for transmission.

NOTE: For Downlink Formats (DF) 0 through 23, the format number corresponds to the binary code in the first 5 bits of the reply. Format number 24 is arbitrarily defined as the format beginning with "11" in the first two bit positions. The following three bits (xxx) vary with reply content.

NOTE: All formats are shown for completeness, although a number of them are unused.

Overview Of Mode S Reply Formats
Table 2

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
AA		24	9-32		X	The aircraft address in the clear, used in DF=11, the All-Call reply.
AC		13	20-32		X	The altitude code used in formats DF=0, 4, 16, and 20. All bits are "0" if altitude information is not available. Contains metric altitude if M-bit (26) is "1".
AP		24 24	33-56 89-112	X	X	Parity overlaid on the address appears at the end of all transmissions, both uplink and downlink, with the exception of format DF=11.
AQ		1	14	X		Designates formats UF=0, 16 as acquisition transmissions. Bit 14 (RI, DF=0, 16) repeats AQ as received by transponder.
CA		3	6-8		X	Reports transponder capability and is used in DF=11, Squitter or All-Call reply. The codes are: 0 = Level 1, no communications capability (surveillance only,) Transponder accepts UF=0, 4, 5, 11; Transponder transmits DF=0, 4, 5, 11. 1 = Level 2, Comm-A and Comm-B capability, Transponder accepts UF=0, 4, 5, 11, 20, 21; Transponder transmits DF=0, 4, 5, 11, 20, 21. 2 = Level 3, Comm-A, Comm-B and uplink ELM capability, Transponder accepts UF=0, 4, 5, 11, 20, 21, 24; Transponder transmits DF=0, 4, 5, 11, 20, 21. 3 = Level 4, Comm-A, Comm-B, uplink and downlink ELM capability, Transponder accepts UF=0, 4, 5, 11, 20, 21, 24; Transponder transmits DF=0, 4, 5, 11, 20, 21, 24. 4 = Level 2, 3, or 4; ability to set code 7 and is on the ground. 5 = Level 2, 3, or 4; ability to set code 7 and is airborne. 6 = Level 2, 3, or 4; ability to set code 7. 7 = DR≠0 or FS=3, 4 or 5. **NOTE**: Codes 4-7 are for Squitters only.
DF		5	1-5		X	The first field in all downlink formats is the transmission descriptor.

Overview of Format Definitions
Table 3

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
DI		3	14-16	X		Identifies coding contained in the SD field in formats UF=4, 5, 20, 21. The codes are: 0 = SD has Interrogator Identifier (IIS). 1 = SD contains (IIS, MBS, MES, LOS, RSS, TMS). 2-6 = Not assigned. 7 = SD contains (IIS, RRS, LOS, TMS).
DR		5	9-13		X	Requests extraction of downlink messages from the transponder by the interrogator and appears in formats DF=4, 5, 20, 21. The codes are: 0 = No downlink request. 1 = Request to send Comm-B message (B bit set) 2 = TCAS information available. 3 = TCAS information available and request to send Comm-B message. 4 = Comm-B Broadcast #1 available. 5 = Comm-B Broadcast #2 available. 6 = TCAS information and Comm-B Broadcast #1 available. 7 = TCAS information and Comm-B Broadcast #2 available. 8-15 = Not assigned. 16-31 = Request to send n-segments, signified by 15 + n. Codes 1-15 take precedence over codes 16-31.
FS		3	6-8		X	Reports the flight status of the aircraft and is used in formats DF=4, 5, 20, 21. The codes are: Code / Alert / SPI / Airborne / On the Ground 0 / no / no / yes / no 1 / no / no / no / yes 2 / yes / no / yes / no 3 / yes / no / no / yes 4 / yes / yes / either 5 / no / yes / either 6, 7 are not assigned.
ID		13	2-32		X	The 4096 identification code, numbers as set by the pilot, in DF=5, 21.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
II		4	10-13	X		Identifies the interrogator and appears in UF=11, the Mode S-Only All-Call. **NOTE**: The same information may also appear in the IIS subfields.
KE		1	4		X	Defines the content of the ND and MD fields in Comm-D replies, DF=24.
MA		56	33-88	X		Messages directed to the aircraft, part of Comm-A interrogations, UF=20, 21.
	ADS	8	33-40	X		Defines the content of the MA message field in Comm-A requests and is expressed in two groups of 4 bits each, ADS1 (33-46) and ADS2 (37-40).
	ADS1	4	33-36	X		Part of the A-Definition Subfield and is set to "0" for TCAS Sensitivity Level Commands.
	ADS2	4	37-40	X		Part of the A-Definition Subfield and is set to "5" for TCAS Sensitivity Level Commands.
	SLC	4	41-44	X		Sensitivity Level Command for the TCAS aircraft. The codes are: 0 = No command. 1 = Not assigned. 2 = Select TA_ONLY mode of operation. 3 = Set TCAS Sensitivity Level to 3. 4 = Set TCAS Sensitivity Level to 4. 5 = Set TCAS Sensitivity Level to 5. 6 = Set TCAS Sensitivity Level to 6. 7 = Set TCAS Sensitivity Level to 7. 8-14 = Not assigned 15=Cancel previous Sensitivity Level command from this site.
MB		56	33-88		X	Messages to be transmitted to the interrogator, part of the Comm-B replies, DF=20, 21. The field contains Data Link Capability Reports or Aircraft Identification Reports or TCAS Resolution Advisory Reports.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
MB	ACS	20	45-64		X	Comm-A capability subfield reports data link service(s) supported by the installation. If all bits are "0", no Comm-A data link services are supported.
	AIS	48	41-88		X	Aircraft Identification Number, reported when a surveillance or Comm-A interrogation (UF=4, 5, 20, 21) contains RR=18 and DI=anything but 7. AIS contains up to eight 6-bit characters as defined in Table 4.
	ARA	14	41-54		X	TCAS Resolution Advisory Report indicating current Active Resolution Advisories (if any) generated by own TCAS unit against one or more threat aircraft. Each bit indicates a specific resolution advisory with "1" being active and "0" being inactive. Bit indications are: 41-Climb. 42-Don't descend. 43-Don't descend faster than 500 FPM. 44-Don't descend faster than 1000 FPM. 45-Don't descend faster than 2000 FPM. 46-Descend. 47-Don't climb. 48-Don't climb faster than 500 FPM. 49-Don't climb faster than 1000 FPM. 50-Don't climb faster than 2000 FPM. 51-Turn left. 52-Turn right. 53-Don't turn left. 54-Don't turn right.
	BCS	16	65-80		X	Comm-B capability subfield reports installed data sources that can be accessed by the ground for transmission via a ground-initiated Comm-B. If all bits are "0", no data is accessible by a ground-initiated Comm-B.
	BDS	8	33-40		X	Defines the content of the MB message field in reply to ground-initiated Comm-B and is expressed in two groups of 4 bits each, BDS1 (33-36) and BDS2 (37-40).

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
MB	BDS1	4	33-36		X	Corresponds with RR in UF=4, 5, 20 and 21. The codes are: 0 = MB contains Air-initiated Comm-B. 1 = MB contains Data Link Capability Report. 2 = MB contains Aircraft Identification. 3 = MB contains TCAS Resolution Advisory. 4-15 = Not assigned.
	BDS2	4	37-40		X	Basic report uses BDS2=0. More complex Mode S installations report additional capabilities in various formats assigned to BDS2 codes other than "0" as requested by interrogator, specified in the RRS subfield of SD.
	CFS	4	41-44		X	Continuation subfield contains the BDS2 value of the next additional capability report available from the installation.
	ECS	8	81-88		X	Data Link Capability subfield reports the ELM capability of the installation. If all bits are "0", no ELM data link services are supported.
	RAC	4	55-58		X	Resolution Advisory Complements subfield indicates currently active resolution advisory complements (if any) received from all other TCAS aircraft with on-board resolution capability. Bits are set to "1" when active and "0" when inactive. Bit indications are: 55-Don't descend. 56-Don't climb. 57-Don't turn right. 58-Don't turn left.
MC		80	9-88	X		Comm-C field contains one segment of a sequence of segments transmitted to the transponder in the ELM mode. MC is part of UF=24.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
MC	SRS	16	9-24	X		If a Comm-C interrogation (UF=24) contains RC=3, the SRS subfield contains a list of segment request-authorizations in the 16-bit (9-24) SRS subfield. Starting with bit 9, denoting the first segment, each of the following bits is set to "1" if the transmission of the corresponding segment is requested.
MD		80	9-88		X	Comm-D field, part of DF=24, contains one segment of a sequence of segments transmitted by the transponder in the ELM mode. It may contain a summary of received MC segments of an uplink ELM.
	TAS	16	17-32		X	Reports the segments received so far in a Comm-C sequence. Starting with bit 17, denoting number "0", each of the following bits is "1" if the corresponding segment of the sequence has been received. TAS appears in MD if KE=1 in the same reply.
MU		56	33-88	X		Field, part of the long air-air surveillance interrogation UF=16, contains information used in air-to-air exchanges (TCAS Resolution Messages and TCAS Broadcast Messages).
	CHC	3	47-49	X		Cancel Horizontal Resolution Advisory Complement. In TCAS Resolution Messages transmitted by TCAS without horizontal resolution capability, CHC is set to "0". The codes are: 0 = No cancellation. 1 = Cancel, don't turn left. 2 = Cancel, don't turn right. 3-7 = Not assigned.
	CVC	2	43-44	X		Cancel Vertical Resolution Advisory Complement. The codes are: 0 = No cancellation. 1 = Cancel, don't descend. 2 = Cancel, don't climb. 3 = Not assigned.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
MU	HRC	3	50-52	X	Horizontal Resolution Advisory Complement. In TCAS Resolution Message transmitted by TCAS without horizontal resolution capability, HRC is set to "0". The codes are: 0 = No horizontal resolution advisory complement sent. 1 = Intruder TCAS sense is turn left/do not turn left. 2 = Intruder TCAS sense is turn left/do not turn right. 3-4 = Not assigned. 5 = Intruder TCAS sense is turn right/do not turn left. 6 = Intruder TCAS sense is turn right/do not turn right. 7 = Not assigned.
	HSB	5	56-60	X	Encoded Sense Bits for Horizontal Resolution Complements provide a parity coding field protecting the six horizontal sense bits (CHC and HRC) and are used in TCAS III Resolution Messages.
	MID	24	65-88	X	Contains the discrete address of the interrogating aircraft and is included in TCAS Resolution Advisories Lock Request, TCAS Resolution Message and TCAS Broadcast Message. **NOTE:** TCAS Broadcast Message is sent at 10-second intervals.
	MTB	1	42	X	Multiple Threat Bit indicates more than one TCAS threat when set to "1" and no more than one threat when set to "0".
	UDS	8	33-40	X	Defines the content of the MU message field and is expressed in two 4-bit groups, UDS1 (33-36) and UDS2 (37-40).
	UDS1	4	33-36	X	Is set to "3" for TCAS Resolution Messages and TCAS Broadcast Messages.
	UDS2	4	37-40	X	Is set to "0" for TCAS Resolution Messages and set to "2" for TCAS Broadcast Messages.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
MU	VRC	2	45-46	X		Vertical Resolution Advisory Complement. The codes are: 0 = No vertical resolution advisory complement sent. 1 = Don't descend. 2 = Don't climb. 3 = Not assigned.
	VSB	4	61-64	X		Encoded Sense Bits for Vertical Resolution Complements provide a parity coding field protecting the four vertical sense bits (CVC and VRC) and is sent in all TCAS Resolution Messages. If bits 43-46 do not agree with bits 61-64, as shown, the TCAS receiver assumes there is an error and disregards message. Bits are set as follows:
MV		56	33-88		X	Field, part of the long air-air surveillance reply DF=16, contains information used in air-to-air exchanges (Coordination Reply Message).

43	44	45	46	61	62	63	64
0	0	0	0	0	0	0	0
0	0	0	1	1	1	1	0
0	0	1	0	0	1	1	1
0	0	1	1	1	0	0	1
0	1	0	0	1	0	1	1
0	1	0	1	0	1	0	1
0	1	1	0	1	1	0	0
0	1	1	1	0	0	1	0
1	0	0	0	1	1	0	1
1	0	0	1	0	0	1	1
1	0	1	0	1	0	1	0
1	0	1	1	0	1	0	0
1	1	0	0	0	1	1	0
1	1	0	1	1	0	0	0
1	1	1	0	0	0	0	1
1	1	1	1	1	1	1	1

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
MV	ARA	14	41-54		X	Same as in MB field.
	RAC	4	55-58		X	Same as in MB field.
	VDS	8	33-40		X	Defines the content of the MV message field and is expressed in two 4-bit groups, VDS1 (33-36) and VDS2 (37-40).
	VDS1	4	33-36		X	Is set to "3" for Coordination Reply Message.
	VDS2	4	37-40		X	Is set to "0" for Coordination Reply Message.
NC		4	5-8	X		Provides the number of the segment transmitted in an uplink ELM and is part of a Comm-C interrogation, UF=24.
ND		4	5-8		X	Provides the number of the segment transmitted in a downlink ELM and is part of a Comm-D reply, DF=24.
PC		3	6-8	X		Contains operating commands to the transponder and is part of surveillance and Comm-A interrogations UF=4, 5, 20, 21. The codes are: 0 = No changes in transponder state. 1 = Non-selective All-Call lockout. 2 = Not assigned. 3 = Not assigned. 4 = Cancel B 5 = Cancel C 6 = Cancel D 7 = Not assigned.
PI		24	33-56		X	Contains the parity overlaid on the interrogator identity code. PI is part of the reply to Mode S-Only All-Call, DF=11.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP DOWN	CONTENT
PR		4	6-9	X	Field contains commands to the transponder specifying the reply probability to the Mode S-Only All-Call interrogation, UF=11 that contains the PR. A command to disregard any lockout state can also be given. The assigned codes are: 0 = Reply with probability = 1. 1 = Reply with probability = 1/2. 2 = Reply with probability = 1/4. 3 = Reply with probability = 1/8. 4 = Reply with probability = 1/16. 5, 6, 7 = Do not reply. 8 = Disregard lockout, reply with probability = 1. 9 = Disregard lockout, reply with probability = 1/2. 10=Disregard lockout, reply with probability = 1/4. 11=Disregard lockout, reply with probability = 1/8. 12=Disregard lockout, reply with probability = 1/16. 13, 14, 15 = Do not reply. **NOTE:** On receipt of a Mode S-Only All-Call containing a PR code other than 0 or 8, transponder executes a random process and makes a reply decision for the interrogation in accordance with the commanded probability. Random occurrence of replies enables interrogator to acquire closely spaced aircraft when replies would otherwise synchronously garble each other.
RC		2	3,4	X	Designates the transmitted segment as initial, intermediate or final if coded "0", "1" or "2" respectively. RC=3 is used to request Comm-D downlink action by the transponder. RC is part of the Comm-C interrogation, UF=24.

Overview of Format Definitions
Table 3 (Cont)

FIELD	SUB FIELD	NO. OF BITS	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
RI		4	14-17		X	Information in DF=0, 16. The codes are: 0 = No on-board TCAS. 1 = Not assigned. 2 = On-board TCAS with resolution capability inhibited 3 = On-board TCAS with vertical-only resolution capability. 4 = On-board TCAS with vertical and horizontal resolution capability. 5-7 = Not assigned. 8 = No maximum airspeed data available. 9 = Airspeed is ≤75 kts. 10=Airspeed is >75 kts and ≤150 kts. 11=Airspeed is >150 kts and ≤300 kts. 12=Airspeed is >300 kts and ≤600 kts. 13=Airspeed is >600 kts and ≤1200 kts. 14=Airspeed is >1200 kts. 15=Not assigned.
RL		1	9	X		Command, sent in UF=0, 16; solicits DF=0 reply, if "0" and DF=16 reply, if "1" (only if transponder is associated with Airborne Collision Avoidance System [ACAS] equipment). Otherwise, in UF=0, "0" solicits DF=0 reply and "1" solicits no reply. In UF=16, "0" solicits DF=16 reply and "1" solicits no reply.
RR		5	9-13	X		Contains length and content of reply requested by the interrogator. RR is part of the surveillance and Comm-A interrogations UF=4, 5, 20, 21.

RR CODE	REPLY LENGTH	MB CONTENT
0-15	Short	N/A
16	Long	Air initiated Comm-B
17	Long	Data link capability
18	Long	Aircraft Identification
19	Long	Resolution Advisories
20-31	Long	Not Assigned

NOTE: If first bit of RR code is "1", decimal equivalent of last four bits of RR code designates code for BDS1 in reply (ground initiated) BDS2 is assumed to be "0" if not specified by DI=7 and RRS.

BINARY	OCTAL	DECIMAL	HEXADECIMAL
000	0	0	0
001	1	1	1
010	2	2	2
011	3	3	3
100	4	4	4
101	5	5	5
110	6	6	6
111	7	7	7
1000	10	8	8
1001	11	9	9
1010	12	10	A
1011	13	11	B
1100	14	12	C
1101	15	13	D
1110	16	14	E
1111	17	15	F
10000	20	16	10

Number Systems Conversion
Table 5

UF#	FIELDS				
0	RL=0	AQ=1			
4	PC=0	RR=0	DI=0	SD=0	
5	PC=0	RR=0	DI=0	SD=0	
11	PR=0	II=0			
16	RL=1	AQ=0	MU=0		
20	PC=0	RR=16	DI=0	SD=0	MA=0
21	PC=0	RR=16	DI=0	SD=0	MA=0

NOTE: Fixed formats apply to Front Panel operation and default remote values (Option 1 installed).

ATC-601 Mode S Interrogation Formats (in Decimal)
Table 6

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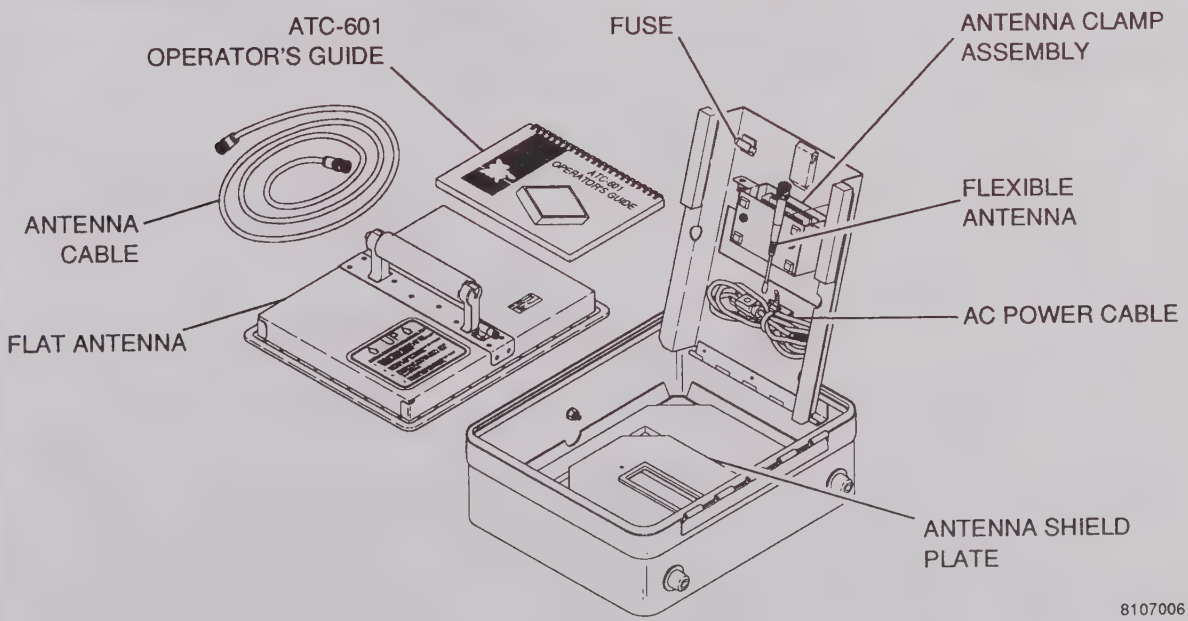
APPENDIX D - AUXILIARY EQUIPMENT

Refer to 1-2-2, Figure 2 for connectors specified with an item number.

1. Storage Compartment (Refer to Figure 1.)

Antenna Clamp Assembly:	Used with Antenna Shield Plate to cover UUT Antenna not being tested.
Flexible Antenna:	RF monopole antenna used with Test Set when power accuracy is not critical and a direct connection is not convenient.
AC Power Cable:	Used to connect ac power from an external source to AC PWR Connector (7).
Antenna Shield Plate:	Used with Antenna Clamp Assembly to cover UUT Antenna not being tested.
Flat Antenna:	RF antenna used with Test Set when power accuracy is most critical.
Antenna Cable:	BNC to BNC coaxial cable used to connect FLAT ANTENNA Connector (22) to ANTENNA Connector (16).
ATC-601 Operator's Guide:	Weatherproof guide for use in the ramp environment.
Fuse:	Spare 1.0 Amp, 250 V Fast-Blo fuse.



Auxiliary Equipment
Figure 1

2. Tripod

Used to hold Test Set Antenna during stationary ramp testing.

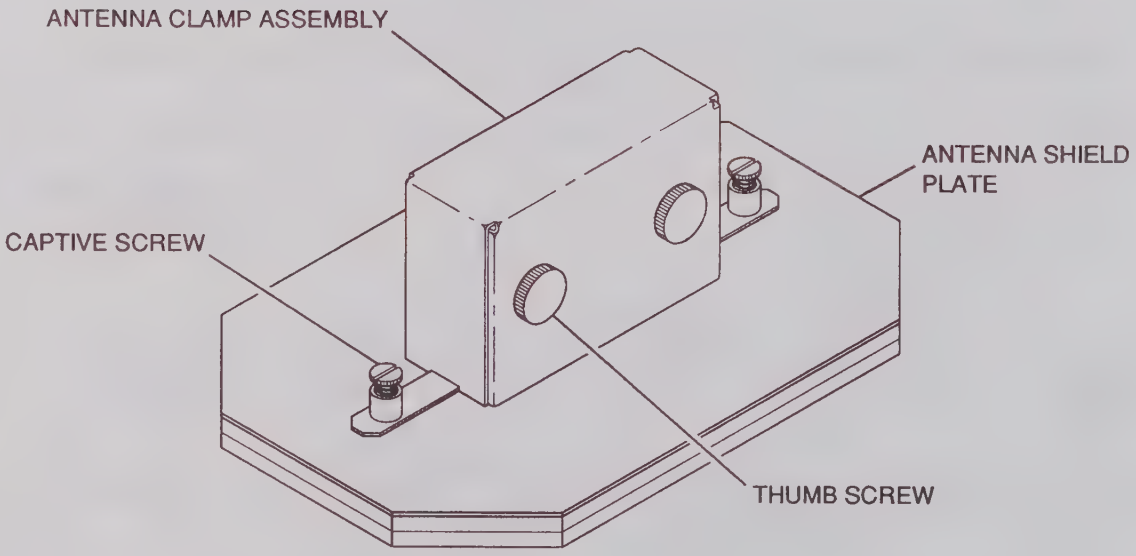
3. Antenna Shield Procedure (Refer to Figure 2.)

STEP	PROCEDURE

1. Position Antenna Clamp Assembly inside the slot in the Antenna Shield Plate, aligning captive screws into the respective screw holes.
2. Tighten captive screws.
3. Cover UUT Antenna with Antenna Shield. Loosen Thumbscrews if necessary.

   NOTE: It may be necessary to remove UUT Antenna Guard if access to UUT Antenna is restricted.

4. Secure Antenna Shield by tightening thumbscrews.



Antenna Shield
Figure 2

APPENDIX F - REMOTE OPERATION (OPTION 1 INSTALLED)

1. General

Installation of Option 1 allows remote operation of the ATC-601 from a PC using Terminal Emulation Software or an RS-232 Terminal.

A. Operation

The ATC-601 must be configured according to 1-2-4B(2) for remote operation. Refer to Appendix F, Subject 3 for Recommended Test Procedures.

B. Syntax

Commands are structured hierarchically through the use of a colon (:) delimiter. Commands with multiple parameter fields separate parameters with a comma (,). An example of a multiple parameter command is: TEST:UF0:UDAT 0,1,#H3AC421 (programming Uplink Format 0 using an address of 3AC421h). At least one space is needed between the command and first parameter. Other spaces or no spaces do not affect the command. Query commands contain a question mark (?) at the end of the command and before any parameters. Query commands request data from the ATC-601. Appendix F, Table 1 shows command syntax punctuation.

PUNCTUATION MARK	NAME	DESCRIPTION
:	Compound Command Separator	Allows hierarchy of command structure.
,	Parameter Separator	Separates parameters in multiple parameter command line.
?	Query Command Ending	Requests return data.

Command Syntax Punctuation Marks
Table 1

Numeric data is in decimal form unless specified otherwise. Other numeric formats (base 2, 8 or 16) are specified by preceeding the data with one of the following character strings:

#B	(Binary [base 2])
#Q	(Octal [base 8])
#H	(Hexadecimal [base 16])

Any specified format may be used to send data, but output (received) data is returned only in the format listed in the applicable Appendix F table.

Commands are entered using short or long form. The short form is shown in upper case and the long form remainder is shown in lower case. Commands, themselves, are not case sensitive. Italicized items indicate variables. Bold items indicate optional reply prefix strings activated by Setup#2 PREFIX STRING = ON or SYSTem:COMMunicate:PREFix 1 command. Parentheses indicate explanations. A backslash (\), not part of the command, indicates the one line command is continued on next line (to fit in the table). Remote operation has only one command per line and one line per command.

2. Commands

A. Nonspecific Commands

COMMAND	RANGE	DEFINITION
*CLS		Clears status command/error queue.
*IDN?	IFR SYSTEMS INC, ATC-601,*serial number,CPU Firmware Version-DSP Firmware Version*	Returns Test Set identification parameters (manufacturer, model, serial number, firmware versions for CPU and DSP).
SYSTem:ERRor?	-32769 to 32767 (decimal format) with "*description*" (0 is no error.)	Returns next entry from 16 entry error queue. Refer to Appendix F, Table 3.
SYSTem:COMMunicate:\ SERial:ECHO *X*	*X*=1 (On) or 0 (Off)	Sets RS232 remote echo state.
SYSTem:COMMunicate:\ SERial:ECHO?	1 or 0	Returns RS232 remote echo state.
SYSTem:COMMunicate:\ PREFix *X*	*X*=1 (Enable) or 0 (Disable)	Enables or disables prefix strings sent with remote test replies.
SYSTem:COMMunicate:\ PREFix?	1 or 0	Returns prefix string control status.
SYSTem:BATTery?	1 (Charged) or 0 (Low)	Returns Battery status.
SYSTem:SCReen *X*	*X*=0 to 27	Displays screen number *X*. Refer to Appendix F, Table 4.
SYSTem:SCReen?	0 to 27	Returns currently displayed screen number.

Nonspecific Commands
Table 2

NUMBER	MESSAGE	DEFINITION
0	NO ERROR	No errors
-102	SYNTAX ERROR	Bad command sent
-108	PARAMETER NOT ALLOWED	Too many parameters sent
-109	MISSING PARAMETER	Too few parameters sent
-120	NUMERIC DATA ERROR	Parameter not a number
-221	SETTINGS CONFLICT	Wrong mode or improper setup
-222	DATA OUT OF RANGE	Parameter out of range
-230	DATA CORRUPT OR STALE	Data possibly invalid
-240	HARDWARE ERROR	Hardware problem
-314	SAVE/RECALL MEMORY LOST	Bad setup
-350	QUEUE OVERFLOW;TOO MANY ERRORS	Too many errors to fit in error queue
-351	QUEUE ERROR;UNDEFINED ERROR	Unknown error number

Error Queue Numbers and Messages
Table 3

SCREEN NUMBER	DISPLAYED SCREEN	SCREEN NUMBER	DISPLAYED SCREEN
0	Auto Test	14	Mode S UF20 Test
1	Reply Delay Test	15	Mode S UF21 Test
2	Reply Jetter Test	16	Squitter Test
3	ATCRBS Reply Test	17	Frequency Test
4	SLS Level Test	18	Diversity Test
5	ATCRBS Only All-Call Test	19	MTL Difference Test
6	Mode S All-Call Test	20	Power Test (Setup#1 Range >0)
7	Invalid Address Test	21	Power Test (Setup#1 Range =0)
8	SPR On/Off Test	22	Self Test
9	Mode S UF0 Test	23	Setup#1 Menu
10	Mode S UF4 Test	24	Setup#2 Menu
11	Mode S UF5 Test	25	Setup#3 Menu
12	Mode S UF11 Test	26	Start-up
13	Mode S UF16 Test	27	Diagnostics

Display Screens
Table 4

B. ATC-601 Specific Commands

COMMAND	RANGE	DEFINITION
SETUP COMMANDS		
ANTenna:TOP *X,Y*	*X*=0 (direct connect) to 300, *Y*=0 to 99 (1 foot increments)	Sets top antenna range and height in feet.
ANTenna:TOP?	0 to 300,0 to 99	Returns top antenna range and height in feet.
ANTenna:BOTTom *X,Y*	*X*=0 (direct connect) to 300 *Y*=0 to 99 (1 foot increments)	Sets bottom antenna range and height in feet.
ANTenna:BOTTom?	0 to 300,0 to 99	Returns bottom antenna range and height in feet.
ANTenna:INPut *X*	*X*=TOP or BOTTOM	Selects which antenna range and height values to be used in testing.
ANTenna:INPut?	TOP or BOTTOM	Returns selected antenna range and height values used in testing.
ANTenna:GAIN *X,Y*	*X*=0.0 to 20.9 (1030 MHz) *Y*=0.0 to 20.9 (1090 MHz) (0.1 dBi increments)	Sets Test Set antenna gain at 1030 MHz and 1090 MHz, in dBi.
ANTenna:GAIN?	0.0 to 20.9,0.0 to 20.9	Returns Test Set antenna gain settings at 1030 MHz and 1090 MHz, in dBi.
ANTenna:LOSS *X*	*X*=0.0 to 9.9 (0.1 dB increments)	Sets coaxial cable loss of Test Set antenna or direct connect cable, in dB.
ANTenna:LOSS?	0.0 to 9.9	Returns coaxial cable loss of Test Set antenna or direct connect cable, in dB.
DIAGNOSTIC COMMANDS		
DIAGnostic:ADDRess *X*	*X*=#H0 to #HFFFFFF (hexadecimal)	Sets address sent in Mode S diagnostics interrogations.
DIAGnostic:ADDRess?	#H0 to #HFFFFFF (hexadecimal)	Returns Mode S address sent in diagnostics interrogations.
DIAGnostic:ATTENuation *X*	*X*=0 to 100 (0=0 dB, each step=0.5 dB)	Sets attenuation for I/O diagnostics test signals.
DIAGnostic:ATTENuation?	0 to 100 (0=0 dB, each step=0.5 dB)	Returns attenuation for I/O diagnostics test signals.
DIAGnostic:DATA?	#H0 to #HFFFFFFFFFFFFFF (data),#H0 to #HFF (status) (hexadecimal)	Returns most recent reply information and status. Refer to 1-2-3C.

ATC-601 Specific Commands
Table 5

COMMAND	RANGE	DEFINITION
DIAGnostic:FAILures?	0 to 2147483647 (-1=not available)	Returns number of diagnostics interrogations sent with no reply received.
DIAGnostic:\ INTERRogations?	0 to 2147483647 (-1=not available)	Returns number of diagnostics interrogations sent.
DIAGnostic:PRF *X*	*X*=1 to 16, 18, 20, 21, 24, 26, 29, 34, 39, 47, 59, 78, 118 or 235	Sets diagnostics interrogation rate (Mode S ≤78).
DIAGnostic:PRF?	1 to 16, 18, 20, 21, 24, 26, 29, 34, 39, 47, 59, 78, 118 or 235	Returns diagnostics interrogation rate.
DIAGnostic:STARt		Starts diagnostics test.
DIAGnostic:STOP		Stops diagnostics test.
DIAGnostic:STYPe	Refer to 1-2-3, Table 2.	Sets diagnostics test signal type.
TEST COMMANDS		
TEST:AC:ATC?	**ATC ALL CALL** - *Status,Reply Status* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Reply Status*=0 (ok), 1 (Mode S transponder replied w/ Mode S.), 2 (Mode S transponder replied w/ ATCRBS.) or 3 (ATCRBS transponder did not reply.)	Returns ATCRBS Only All-Call Test results.
TEST:AC:ATC:STARt		Runs ATCRBS Only All-Call Test.
TEST:AC:S?	**MODE S ALL CALL** - *Status, Reply Status,Tail Number,All-Call Address,DF4 Address* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Reply Status*=0 (ok), 1 (No DF4 reply), 2 (No DF11 reply), 3 (no reply to test interrogations) or 4 (DF4 reply valid) *Tail Number*=6 ASCII characters *All-Call Address*=24 bit/ hexadecimal *DF4 Address*=24 bit/hexadecimal (only if invalid)	Returns Mode S All-Call Test data.
TEST:AC:S:STARt		Runs Mode S All-Call Test.

ATC-601 Specific Commands
Table 5 (Cont)

COMMAND	RANGE	DEFINITION
TEST:ADDRess?	**INVALID ADDRESS** - *Status, Reply Status,Invalid Address 1, Invalid Address 2* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Reply Status*=0 (ok), 1 (Replied to *Invalid Address 1*), 2 (Replied to *Invalid Address 2*), 3 (Replied to *Invalid Addresses 1 and 2*) *Invalid Address 1*=24 bit/ hexadecimal (only if invalid) *Invalid Address 2*=24 bit/ hexadecimal (only if invalid)	Returns Invalid Address Test data.
TEST:ADDRess:STARt		Runs Invalid Address Test.
TEST:ALL?	Refer to Appendix F, 2C.	Returns all test data.
TEST:ATCReply?	**ATCRBS REPLY** - *Status,Status Flags,Spacing-A,Spacing-C,*F_1 *Width-A,*F_1 *Width-C,*F_2 *Width-A,* F_2 *Width-C*,ID (SPI indicator, not shown otherwise),*Code,Altitude* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (6 flags/Spacing-A, Spacing-C, F_1 Width-A, F_1 Width-C, F_2 Width-A, F_2 width-C) *Spacing-A=xx.xx* (Mode A spacing in µs) *Spacing-C=xx.xx* (Mode C spacing in µs) F_1 *Width-A=x.xx* (Mode A F_1 width in µs) F_1*Width-C=x.xx* (Mode C F_1 width in µs) F_2 *Width-A=x.xx* (Mode A F_2 width in µs) F_2 *Width-C=x.xx* (Mode C F_2 width in µs) *Code*=13 bit/octal (Mode A ID) *Altitude*=24 bit/decimal (Mode C altitude in feet)	Returns ATCRBS Reply Test data.
TEST:ATCReply:STARt		Runs ATCRBS Reply Test.

ATC-601 Specific Commands
Table 5 (Cont)

COMMAND	RANGE	DEFINITION
TEST:AUTO?	**AUTO** - *Status,Status Flags,Test Modes,Pass Modes,Fail Modes, Freq, ERP,MTL,Diversity* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (2 flags/ERP,MTL power tests) *Test Modes* =(1 to 3 Modes-ACS) *Pass Modes*=(1 to 3 Modes-ACS) *Fail Modes*=(1 to 3 Modes-ACS) *Freq=xxxx.xx* (in MHz) *ERP=xxx* dBm, dBw or WATTS *MTL=xxx* dBm *Diversity=xxx* (in dB)	Returns Auto Test data.
TEST:AUTO:DIV *X*	*X*=0 (Disable) or 1 (Enable)	Sets Diversity Test run status.
TEST:AUTO:DIV?	0 or 1	Returns Diversity Test run status.
TEST:AUTO:STARt		Runs Auto Test.
TEST:COUNt?	0 to 2147483647	Returns Data Update Counter Count (resets to 0 at start of test and increments with each new data update).
TEST:DIVersity?	**DIVERSITY** - *Status,Diversity*, SATURATED (when saturated) *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Diversity=xxx* (Valid Diversity in dB)	Returns Diversity Test data.
TEST:DIVersity:STARt		Runs Diversity Test.
TEST:FREQuency?	**FREQUENCY** - *Status,Freq* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Freq=xxxx.xx* (UUT Frequency in MHz)	Returns Frequency Test data.
TEST:FREQuency:\ STARt		Runs Frequency Test.
TEST:MTLDiff?	**MTL DIFFERENCE** - *Status,Diff* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Diff=xxx.x* (MTL difference between Modes A and C, in dB)	Returns MTL Difference Test data.
TEST:MTLDiff:STARt		Runs MTL Difference Test.

ATC-601 Specific Commands
Table 5 (Cont)

COMMAND	RANGE	DEFINITION
TEST:POWer?	**POWER** - *Status,Status Flags, Antenna,ERP,MTL* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (2 flags/ERP,MTL power tests) *Antenna*=TOP or BOTTOM *ERP=xxx.x* dBm, dBw or WATTS *MTL=xxx.x* dBm (*** - multipath)	Returns Power Test data.
TEST:POWer:STARt		Runs Power Test.
TEST:POWer:UNIT *X*	*X*=DBM, DBW or WATTS	Sets ERP measurement units for Power Test.
TEST:POWer:UNIT?	dBm, dBw or WATTS (default dBm)	Returns ERP measurement units.
TEST:RDELay?	**REPLY DELAY** - *Status,Status Flags,Mode S,ITM A,ITM C, ATC A,ATC C* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (5 flags/Mode S, ITM A, ITM C, ATC A, ATC C) *Mode S=xxx.xx* (in µs) *ITM A=xxx.xx* (in µs) *ITM C=xxx.xx* (in µs) *ATC A=x.xx* (in µs) *ATC C=x.xx* (in µs)	Returns Reply Delay Test data.
TEST:RDELay:STARt		Runs Reply Delay Test.
TEST:RECall *X*	*X*=1 or 2 (Memory Location)	Recalls test data.
TEST:RJITter?	**REPLY JITTER** - *Status,Status Flags,Mode S,ITM A,ITM C, ATC A,ATC C* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (5 flags/Mode S, ITM A, ITM C, ATC A, ATC C) *Mode S=x.xx* (in µs) *ITM A=x.xx* (in µs) *ITM C=x.xx* (in µs) *ATC A=x.xx* (in µs) *ATC C=x.xx* (in µs)	Returns Reply Jitter Test data.
TEST:RJITter:STARt		Runs Reply Jitter Test.
TEST:RUNning?	0 (Test not running) or 1 (Test running)	Return test running status

ATC-601 Specific Commands
Table 5 (Cont)

COMMAND	RANGE	DEFINITION
TEST:SELF?	**SELF** - *Status,Status Flags, Failure Code* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (3 flags/RF Module, Digital Module, Power Supply/Battery) *Failure Code*=(Refer to 1-2-3, Table 1.) (only with failure)	Returns Self Test data.
TEST:SELF:STARt		Runs Self Test.
TEST:SLSLevel?	**SLS LEVEL** - *Status,Status Flags,-9dB,0dB* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (2 flags/-9dB, 0dB) *-9dB*=REPLY or NO REPLY *0dB*=REPLY or NO REPLY	Returns SLS Level Test data.
TEST:SLSLevel:STARt		Runs SLS Level Test.
TEST:SPR?	**SPR** - *Status,Status Flags,On,Off* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (2 flags/On, Off) *On*=REPLY or NO REPLY *Off*=REPLY or NO REPLY	Returns SPR On/Off Test data.
TEST:SPR:STARt		Runs SPR On/Off Test.
TEST:SQTR?	**SQUITTER** - *Status,Period,Tail Number,Squitter Address* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Period=xx.xx* (between squitters in seconds) *Tail Number*=6 ASCII characters *Squitter Address*=24 bit/ hexadecimal	Returns Squitter Test data.
TEST:SQTR:STARt		Runs Squitter Test.
TEST:STOP		Stops current test.
TEST:STORe *X*	*X*=1 or 2 (Memory Location)	Stores test data.

ATC-601 Specific Commands
Table 5 (Cont)

COMMAND	RANGE	DEFINITION
TEST:UF0:DDATa?	**MODE S UF0** - *Status,Status Flags,DF,VS,RI,AC,Address* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (3 flags/DF, AC, Address) *DF*=5 bits/decimal *VS*=1 bit/decimal *RI*=4 bits/hexadecimal *AC*=13 bits/decimal *Address*=24 bit/hexadecimal (Refer to Appendix C for Downlink Format field definitions.)	Returns Mode S UF0 Test data.
TEST:UF0:STARt?		Runs Mode S UF0 Test.
TEST:UF4:DDATa?	**MODE S UF4** - *Status,Status Flags,DF,FS,DR,UM,AC,Address* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (3 flags/DF, AC, Address) *DF*=5 bits/decimal *FS*=3 bits/decimal *DR*=5 bits/hexadecimal *UM*=6 bits/hexadecimal *AC*=13 bits/decimal *Address*=24 bit/hexadecimal (Refer to Appendix C for Downlink Format field definitions.)	Returns Mode S UF4 Test data.
TEST:UF4:STARt		Runs Mode S UF4 Test.
TEST:UF5:DDATa?	**MODE S UF5** - *Status,Status Flags,DF,FS,DR,UM,ID,Address* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (3 flags/DF, ID, Address) *DF*=5 bits/decimal *FS*=3 bits/decimal *DR*=5 bits/hexadecimal *UM*=6 bits/hexadecimal *ID*=13 bits/octal *Address*=24 bit/hexadecimal (Refer to Appendix C for Downlink Format field definitions.)	Returns Mode S UF5 Test data.
TEST:UF5:STARt		Runs Mode S UF5 Test.

ATC-601 Specific Commands
Table 5 (Cont)

COMMAND	RANGE	DEFINITION
TEST:UF11:DDATa?	**MODE S UF11** - *Status,Status Flags,DF,CA,PI,AA* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (2 flags/DF, AA) *DF*=5 bits/decimal *CA*=3 bits/decimal *PI*=24 bits/hexadecimal *AA*=24 bit/hexadecimal (Refer to Appendix C for Down-link Format field definitions.)	Returns Mode S UF11 Test data.
TEST:UF11:STARt		Runs Mode S UF11 Test.
TEST:UF16:DDATa?	**MODE S UF16** - *Status,Status Flags,DF,VS,RI,MV,AC,Address* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (3 flags/DF, AC, Address) *DF*=5 bits/decimal *VS*=1 bit/decimal *RI*=4 bits/hexadecimal *MV*=56 bits/hexadecimal *AC*=13 bits/decimal *Address*=24 bit/hexadecimal (Refer to Appendix C for Down-link Format field definitions.)	Returns Mode S UF16 Test data.
TEST:UF16:STARt		Runs Mode S UF16 Test.
TEST:UF20:DDATa?	**MODE S UF20** - *Status,Status Flags,DF,FS,DR,UM,MB,AC, Address* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (3 flags/DF, AC, Address) *DF*=5 bits/decimal *FS*=3 bits/decimal *DR*=5 bits/hexadecimal *UM*=6 bits/hexadecimal *MB*=56 bits/hexadecimal *AC*=13 bits/decimal *Address*=24 bit/hexadecimal (Refer to Appendix C for Down-link Format field definitions.)	Returns Mode S UF20 Test data.
TEST:UF20:STARt		Runs Mode S UF20 Test.

ATC-601 Specific Commands
Table 5 (Cont)

COMMAND	RANGE	DEFINITION
TEST:UF21:DDATa?	**MODE S UF21 -** *Status,Status Flags,DF,FS,DR,UM,MB,ID, Address* *Status*=PASSED, FAILED, NOT RUN or NO REPLY *Status Flags*=P (Pass) or F (Fail) (3 flags/DF, AC, Address) *DF*=5 bits/decimal *FS*=3 bits/decimal *DR*=5 bits/hexadecimal *UM*=6 bits/hexadecimal *MB*=56 bits/hexadecimal *ID*=13 bits/octal *Address*=24 bit/hexadecimal (Refer to Appendix C for Down-link Format field definitions.)	
TEST:UF21:STARt		Runs Mode S UF21 Test.
UPLINK DATA COMMANDS		
TEST:UF0:UDATa *X*	*X*=0 or 1 (RL),0 or 1 (AQ) (Refer to Appendix C for Uplink Format field definitions.)	Sets UF0 data fields.
TEST:UF0:UDATa?	0 or 1 (RL),0 or 1 (AQ)	Returns UF0 data.
TEST:UF4:UDATa *X*	*X*=0 to 7 (PC),#H0 to #H1F (RR), 0 to 7 (DI),#H0 to #HFFFF (SD) (Refer to Appendix C for Uplink Format field definitions.)	Sets UF4 data fields.
TEST:UF4:UDATa?	0 to 7 (PC),#H0 to #H1F (RR), 0 to 7 (DI),#H0 to #HFFFF (SD)	Returns UF4 data.
TEST:UF5:UDATa *X*	*X*=0 to 7 (PC),#H0 to #H1F (RR),0 to 7 (DI),#H0 to #HFFFF (SD) (Refer to Appendix C for Uplink Format field definitions.)	Sets UF5 data fields.
TEST:UF5:UDATa?	0 to 7 (PC),#H0 to #H1F (RR),0 to 7 (DI),#H0 to #HFFFF (SD)	Return UF5 data.
TEST:UF11:UDATa *X*	*X*=#H0 to #HF (PR),#H0 to #HF (II) (Refer to Appendix C for Uplink Format field definitions.)	Sets UF11 data fields.
TEST:UF11:UDATa?	#H0 to #HF (PR),#H0 to #HF (II)	Returns UF11 data.
TEST:UF16:UDATa *X*	*X*=0 or 1 (RL),0 or 1 (AQ),#H0 to #HFFFFFFFFFFFFFF (MU) (Refer to Appendix C for Uplink Format field definitions.)	Sets UF16 data fields.
TEST:UF16:UDATa?	0 or 1 (RL),0 or 1 (AQ),#H0 to #HFFFFFFFFFFFFFF (MU)	Returns UF16 data.

ATC-601 Specific Commands
Table 5 (Cont)

COMMAND	RANGE	DEFINITION
TEST:UF20:UDATa *X*	*X*=0 to 7 (PC),#H0 to #H1F (RR),0 to 7 (DI),#H0 to #HFFFF (SD),#H0 to #HFFFFFFFFFFFFFF (MA) (Refer to Appendix C for Uplink Format field definitions.)	Sets UF20 data fields.
TEST:UF20:UDATa?	0 to 7 (PC),#H0 to #H1F (RR),0 to 7 (DI),#H0 to #HFFFF (SD),#H0 to #HFFFFFFFFFFFFFF (MA)	Returns UF20 data.
TEST:UF21:UDATa *X*	*X*=0 to 7 (PC),#H0 to #H1F (RR),0 to 7 (DI),#H0 to #HFFFF (SD),#H0 to #HFFFFFFFFFFFFFF (MA) (Refer to Appendix C for Uplink Format field definitions.)	Sets UF21 data fields.
TEST:UF21:UDATa?	0 to 7 (PC),#H0 to #H1F (RR),0 to 7 (DI),#H0 to #HFFFF (SD),#H0 to #HFFFFFFFFFFFFFF (MA)	Returns UF21 data.
TEST:UF:UDATa:\ DEFault		Sets data for all UF interrogations to initial default settings. Refer to Appendix C, Table 6.

ATC-601 Specific Commands
Table 5 (Cont)

C. TEST:ALL? and Data Dump Information

The TEST:ALL? query reply and the test data transmitted to the Host System when activating DUMP TEST DATA = 0 in the Setup#2 Menu Screen contain the same information. The TEST:ALL? query reply separates each set of individual test or data information with a semicolon. The data dump places each set of individual test or data information at the start of a new line.

NOTE: Data dumps do not require installation of Option 1.

(1) Data

Data dumps and TEST:ALL? query replies contain the following:

*IDN? query reply
TEST:SELF? query reply
TEST:AUTO? query reply
TEST:RDELay? query reply
TEST:RJITter? query reply
TEST:ATCReply? query reply
TEST:SLSLevel? query reply
TEST:AC:ATC? query reply
TEST:AC:S? query reply
TEST:ADDRess? query reply
TEST:SPR? query reply
TEST:UF0:DDATa? query reply
TEST:UF4:DDATa? query reply
TEST:UF5:DDATa? query reply
TEST:UF11:DDATa? query reply
TEST:UF16:DDATa? query reply
TEST:UF20:DDATa? query reply
TEST:UF21:DDATa? query reply
TEST:SELF? query reply
TEST:SQTR? query reply
TEST:FREQuency? query reply
TEST:DIVersity? query reply
TEST:MTLDiff? query reply
TEST:POWer? query reply

(2) Examples

The following is an example of a TEST:ALL? query reply:

IFR SYSTEMS INC,ATC-601,0,0106-0100;**SELF -** PASSED,PPF,#H10;**AUTO -** FAILED,PP,ACS,AC,S,1090,156 WATTS,-73 dBm,25;**REPLY DELAY -** FAILED, FPPPP,129.05,128.02,128.04,3.02,3.10;**REPLY JITTER -** PASSED,PPPPP,.03, .05,.05,.1,.07;**ATCRBS REPLY -** PASSED,PPPPP,20.3,20.3,.45,.45,.45,.45,ID, #Q777,10700;**SLS LEVEL -** PASSED,PP,REPLY,NO REPLY;**ATC ALL CALL -** PASSED,0;**MODE S ALL CALL -** PASSED,0,N12345,#H3AC421;**INVALID ADDRESS -** PASSED,0,,;**SPR -** PASSED,PP,REPLY,NO REPLY;**MODE S UF0 -** PASSED,PPP,0,1,#HC,10700,#H3AC421;**MODE S UF4 -** PASSED,PPP,4,1, #H0,#H0,10700,#H3AC421;**MODE S UF5 -** PASSED,PPP,5,1,#H0,#H0,#Q7777, #H3AC421;**MODE S UF11 -** PASSED,PP,11,1,#H0,#H3AC421;**MODE S UF16 -** PASSED,PPP,16,0,#H0,#H0,10700,#H3AC421;**MODE S UF20 -** PASSED,PPP, 20,0,#H0,#H0,#H0,10700,#H3AC421;**MODE S UF21 -** PASSED,PPP,21,0,#H0, #H0,#H0,#Q7777,#H3AC421;**SQUITTER -** PASSED,1,N12345,#H3AC421; **FREQUENCY -** PASSED,1092.3;**DIVERSITY -** PASSED,27,,#H3AC421;**MTL DIFFERENCE -** PASSED,.2;**POWER -** PASSED,PP,TOP,156 WATTS,-73.4 dBm

The following is an example of a data dump containing the same information as the TEST:ALL? query reply in the previous example:

IFR SYSTEMS INC,ATC-601,0,0106-0100
SELF - PASSED,PPF,#H10
AUTO - FAILED,PP,ACS,AC,S,1090,156 WATTS,-73 dBm,25
REPLY DELAY - FAILED,FPPPP,129.05,128.02,128.04,3.02,3.10
REPLY JITTER - PASSED,PPPPP,.03,.05,.05,.1,.07
ATCRBS REPLY - PASSED,PPPPP,20.3,20.3,.45,.45,.45,.45,ID,#Q777,10700
SLS LEVEL - PASSED,PP,REPLY,NO REPLY
ATC ALL CALL - PASSED,0
MODE S ALL CALL - PASSED,0,N12345,#H3AC421
INVALID ADDRESS - PASSED,0,,
SPR - PASSED,PP,REPLY,NO REPLY
MODE S UF0 - PASSED,PPP,0,1,#HC,10700,#H3AC421
MODE S UF4 - PASSED,PPP,4,1,#H0,#H0,10700,#H3AC421
MODE S UF5 - PASSED,PPP,5,1,#H0,#H0,#Q7777,#H3AC421
MODE S UF11 - PASSED,PP,11,1,#H0,#H3AC421
MODE S UF16 - PASSED,PPP,16,0,#H0,#H0,10700,#H3AC421
MODE S UF20 - PASSED,PPP,20,0,#H0,#H0,#H0,10700,#H3AC421
MODE S UF21 - PASSED,PPP,21,0,#H0,#H0,#H0,#Q7777,#H3AC421
SQUITTER - PASSED,1,N12345,#H3AC421
FREQUENCY - PASSED,1092.3
DIVERSITY - PASSED,27,,#H3AC421
MTL DIFFERENCE - PASSED,.2
POWER - PASSED,PP,TOP,156 WATTS,-73.4 dBm

3. Recommended Test Procedures

A. General

Do not change data when DIAGnostics:STARt or any TEST:*Test*:STARt (*Test*=specific test) command has been initiated (test is running). Change data only when tests are not currently running. The TEST:STOP command can be issued as many times as needed without causing problems. However, all tests, except Auto Test, do not automatically stop.

NOTE: The TEST:SELF:STARt command shuts off all interrupts including RS-232. Remote commands sent during Self Test are disregarded and lost. Do not send RS-232 commands for duration of the Self Test (≈10 seconds).

B. Procedures

(1) Other than Auto Test

STEP	PROCEDURE
1.	Send TEST:*Test*:STARt command. (*Test*=specific test to run.)
2.	Send TEST:COUNt? query.
3.	Loop previous query until data changes.
4.	Send TEST:*Test*? query.
5.	Loop to the TEST:COUNt? query to collect more data.
6.	Send TEST:STOP command.

(2) Auto Test

STEP	PROCEDURE
1.	Send TEST:AUTO:STARt command.
2.	Send TEST:RUNning? query.
3.	Loop previous query until zero.
4.	Send TEST:AUTO? command.

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